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THE CONNECTICUT AVENUE BRIDGE AT WASHINGTON, D. C.

The city of Washington is bounded on the north and west by a gorge averaging 1,500 ft. in width and 130 ft. in depth, through which flows a small stream known as Rock Creek. Up to recent years this gorge has marked the extreme limits of the urban population with but a meager suburban settlement beyond, but within the past decade the growth of the city in this direction has passed the gorge and now the country lying just across the creek is being rapidly converted into building lots, while the more distant subdivisions are the most desirable of all the suburban additions to the capital city. Near the mouth of the creek where it empties into the Potomac, the connection between the city proper and the old town of Georgetown, now a part of Washington, is made by numerous railway and highway bridges, but above Georgetown, where the gorge is through a country not yet denuded of its timber the street crossings are few and far between. The recent great development of this latter portion of the city led Congress about eleven years ago to appropriate funds for the construction of a monumental bridge or viaduct across the gorge on the line of Connecticut Ave., which continues in practically a straight line from one of the widest and most prominent boulevards in the city across the gorge out to the District line some five miles distant. Three engineers were asked to submit designs (Eng. News, Jan. 27, 1898, p. 54), and after due consideration of the various plans the design of the late George S. Morison was accepted. Under this design, with some minor changes, the erection was carried out and the finished bridge was opened to the public about the beginning of the present year.

We publish in this issue two views of the structure taken since it was opened for traffic. In many of our previous issues we have described the design and construction of the bridge (Eng. News, June 1, 1905, p. 571), so it is not necessary here to enter into its details. Suffice it to say that it is 1,341 ft. long and 52 ft. wide and consists of five 150 ft. and two 82 ft. arches, all semi-circular in outline. It is built throughout of concrete, non-reinforced mass work being used in the piers and rings and solid dressed blocks for the facing arch ring stones, the quoins and for moldings.

On account of the picturesque character of the natural surroundings every effort has been made to enhance the dignified original design by as artistic ornamentation as possible. All surfaces have a bush-hammered finish, which does much to bring out the pleasing contrast between the yellowish tint of the main face work and the granitic gray of the cast block trimmings. The lower end of a government reservation reaches below the bridge site with much-traveled roads passing under each of the smaller arches, so that the details of finish and design have to be more refined than in the ordinary concrete bridge which is not under such critical observation. So also the roadway, being one of the main thoroughfares of the city for pleasure riding, is decorated somewhat more than is usual in city bridges. The railing is of plain iron bar verticals carried on ornamental iron hand and base rails between cast stone balusters spaced about every 16 ft. At each pier cast pilasters carry highly ornamental lamp posts molded out of cast iron. At each side of each abutment there is a heavy pedestal on which there is to be placed a heroic size crouching lion cast in place in concrete. These lions have been modeled by Mr. R. Hinton Perry, and are to be cast by the Erkins Co. of New York City. Although the roadway has been designed to carry a street railway, at present there is no franchise for such a road, and it is understood that none will be granted unless the requirements become much more exigent than at present.

The bridge was constructed while Col. John Biddle, U. S. A., was Engineer Commissioner of the District of Columbia, with Captain J. J. Morrow, Assistant Engineer, Commissioner. It was under the direct charge of Mr. W. J. Douglas,

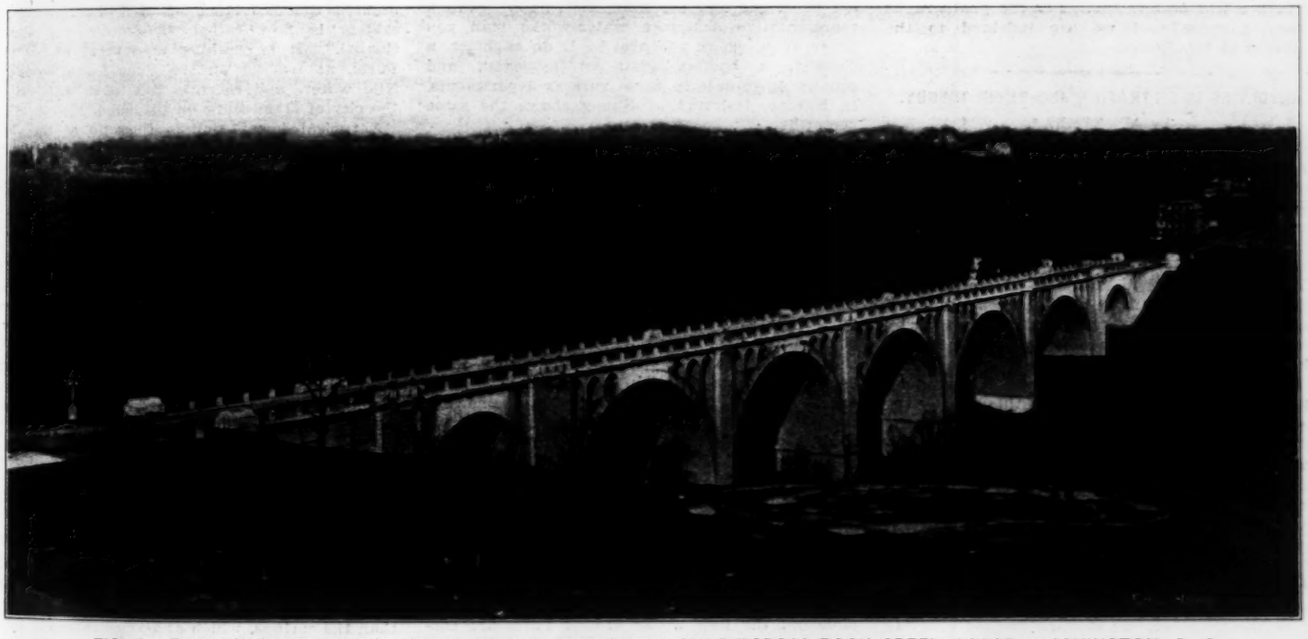


FIG. 1. THE CONCRETE BRIDGE CARRYING CONNECTICUT AVENUE ACROSS ROCK CREEK GORGE, WASHINGTON, D. C.
(1,341 ft. long containing five 150-ft. and two 82-ft. arches. Mass concrete with solid concrete block quoins and moldings.)

M. Am. Soc. C. E., Engineer of Bridges, and Mr. F. A. Perley, Assistant Engineer of Bridges, with Mr. E. P. Casey as consulting architect. Two of the foundations for the piers were put in by the Cranford Paving Co., but the remainder of the entire construction was carried out by the

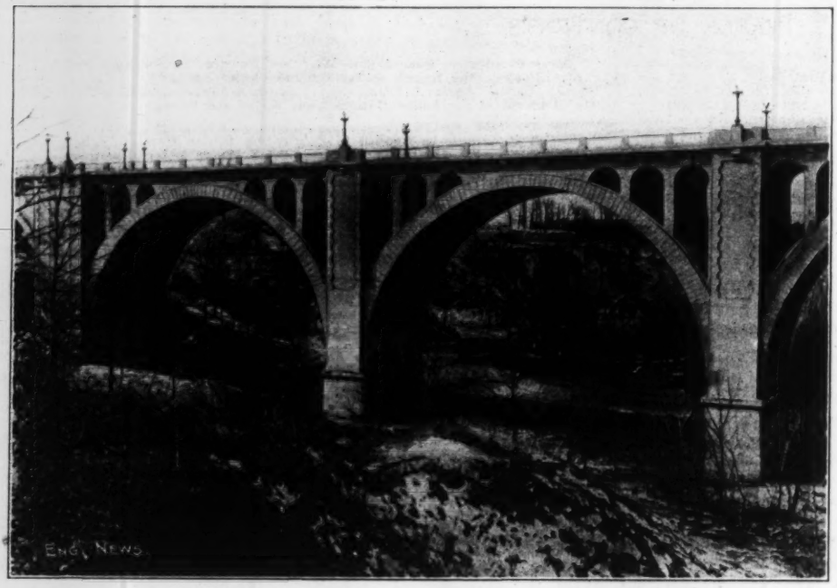


FIG. 2. THE 150-FT. ARCHES OF THE CONNECTICUT AVENUE BRIDGE.

District Construction Co. The cost of the entire structure will be $850,000. For the photographs herewith reproduced we are indebted to the courtesy of Mr. Douglas.

NOVELTIES IN FILTRATION AND THEIR THEORY.

By AD. KEMNA.*

Filtration of large volumes of water for the supply of towns was started in 1829 by Simpson, who built the first sand filter for the Chelsea Water Co., of London. The process spread gradually in England, and was introduced on the European continent, the latter by English companies (in the early fifties, Amsterdam, Berlin). The mode of construction and of working remained practically unaltered, the only addition being preliminary treatment of the water by sedimentation in large reservoirs, which is still characteristic of English practice.

In the eighties the question was taken up by the Germans, both from the scientific side by the hygienists and from the practical side by the engineers. The first works with many improvements were erected for Warsaw by Lindley: the currents in the settling reservoirs were modified according to the seasonal changes in the temperature and density of the water, a constant water level was maintained on the filters and their speed was automatically controlled. Andreas Meyer followed on the same lines for Hamburg (construction started in 1890). About this time came the microbes, the gelatine method allowing an easy counting, and Koch's "practical" rules. The characteristics of that period, in Germany, was the co-operation of the engineer and the scientist, not without some exaggeration from the scientist and some reluctance from the engineer; but, on the whole, these were minor troubles and the general results were improvements under the influence of scientific control.

The special feature of American water supplies is the enormous waste; it would be ruinous to treat such large quantities of water efficiently, so generally there is no purification whatever. A radical cure for wanton use is metering the supply, but it seems that too often local politics prevent this. There is a Dutch saying that he who will not hear must feel; typhoid acted as a convincing teacher and of late years much has been done in the United States towards improving the supply. In former years, however, the liberal spirit of the Massachusetts Board of Health started the Lawrence experimental plant, a magnificent piece of work through the complete blending of true science with practical engineering. There is no friction possible, because the engineer and the scientist are often one and the same individual. With a representative American water-works man you never know where you are: he is an engineer, a chemist, a bacteriologist, an hygienist, and equally up-to-date in these various departments. In Europe, Imbeaux of Nancy shows the same versatility.

France has taken for a long time a somewhat isolated position. Springs only, because of their "natural purity," were considered safe and any attempt at artificial purification of surface waters was distrusted; especially sand filtration was disqualified as a mere straining. After a first attempt at Libourne by the engineer, Mr. Noel, the big Compagnie Générale des Eaux took up the matter and its chief engineer, Mr. Boutan, erected at Choisy le Roi sand filters with iron purification (Anderson's revolving purifier) for the greatest part of the Paris suburbs. The usual immediate reduction of typhoid was, however, ignored in hygienic circles, somewhat through the fault of the Compagnie Générale itself, systematically abstaining from publication. It was only when Mr. Chabal drew attention to German and English statistics in favor of filtered supplies that the French hygienists began to see that the process was worth something and that filtration works could be erected without meeting with official opposition. In coming in late, there is the advantage of being able to profit by the experience of pioneers; the new works around Paris are certainly up-to-date.

Two other causes have cooperated to make these works of special interest. The opposition to sand filtration was on purely theoretical grounds, with the most singular disregard of plain and actual facts; but it had the effect of inciting the engineer to do his utmost to comply with the somewhat exaggerated demands of the hygienist. On the other hand, the French have pride—the idea of simply doing as is done everywhere else is unbearable to their mind; hence a certain number of novelties.

First in importance amongst these novelties are the gravel strainers called "dégrossisseurs." Their history (Mémoires Société des Ingénieurs Civils de France, Mai 1900, 2e quinzaine) is as follows: Mr. Armand Puech, a cloth manufacturer at Mazamet, Department Tarn, in the south of France, had much trouble with muddy waters in his factory. To wash a piece of cloth the water is applied in a spray thro[ugh] a pipe with small holes; these holes got [clo]ged by matter in suspension. He tried [filt]ration through sponges, which had to be c[lean]ed every two days and renewed every month[s] then resorted to clinker or cinder, but th[is] material was difficult to clean and its renew[al] was expensive for labor. A sand filter wa[s] used but the available head being only [1.] m. (3.9 ft.) the deeper layer of coarse gra[vel] was replaced by a perforated sheet of iron, [sup]porting 0.10 m. (4 ins.) of small gravel and [0.]m. (16 ins.) of sand; this filter clogged rapid[ly.] Therefore the sand was dispensed with. [At] first the water passed was more or less opa[que,] but gradually the effluent grew better. [An] important advantage of the plant is great [vel]ocity, a column of water of 30 to 40 m. (100 to [130] ft.) per 24 hrs., about 15 times more than a sand filter. Thus the fact was experimentally established that mere gravel straining at comparatively high speed can clarify a muddy water.

In order to ensure better clarification, the thickness of gravel was increased from 10 to 25 cm. (4 to 10 ins.) with the result that the effluent was better but clogging more rapid. It was then thought that "the mesh of the filter should be proportionated to the size of the particles," which led to the idea of using in succession various grades of gravel of diminishing size, with larger surface areas, which means diminishing speed. The results being highly satisfactory, Mr. Puech hit upon the idea that his gravel strainers, doing a lot of work, would relieve ordinary sand filters of all that part of their burden, prolong their life and ensure better results. By facilitating the adoption of sand filtration for municipalities, a large field was open. Not being himself an engineer, he secured the assistance of Mr. Chabal, and the system is now called "Dégrossisseurs Puech-Chabal." It is working in several places near Paris, at Ismalia on the Suez Canal with the Nile water, and recently has been adopted for the city of Magdeburg on the Elbe.

A typical installation is the one of the Compagnie des Eaux de la banlieue de Paris, supplying some localities to the west and south, with a maximum of 35,000 cu. m. (9,250,000 U. S. gals.); it is at Suresnes, on the slope of the Mont Valerien. The water goes through four beds of gravel at successive speeds of 240, 140, 78 and 47 m. and then through two sand filters at 16 and at 2.78 m. [Approximately 225,000,000, 130,000,000, 75,000,000 and 45,000,000 U. S. gals. per acre per day for the gravel filters and 15,000,000 and 2,500,000 for the sand filters.—Ed.] The plant was started by the middle of November, 1905, and visited ten days later by the newly-founded French association of municipal engineers. The river was at its worst, in full flood, a thick, yellow liquid; the effluent from the gravel strainers was scarcely opalescent. Bacterial analyses of water from the last sand filters gave generally much less than 100 colonies. These analyses are made by Miquel, who applies his method of counting after 15 days; his figures are several times higher than with the usual gelatine method after three days; they are much lower than the springs, which at Paris continue more or less to be considered as standard. The last filters run for an indefinite period, more than a year, and even then their loss of head is only 20 cm. (8 ins.).

An experiment has been made at Waelhem, the filtering station of the Antwerp Water-Works Co. An ordinary sand filter of 900 sq. m. [.22-acre] was supplied by a gravel strainer of 100 sq. m. [.024-acre] in three compartments of 25, 25 and 50 sq. m. At the normal speed of 10 cm. per hr., the first two compartments pass a colum of water 86.4 m. per 24 hrs., and the third 43.2 m. [80,000,000 and 40,000,000 U. S. gals. per acre per day]. Mixed gravel the same in all compartments was used, but the first compartment clogged quickly; the gravel was then screened in three sizes and now the system works satisfactorily, the effluent being only slightly opalescent.

The degree of mechanical improvement, i. e.,

*Direktor Antwerp Water-Works Co., 6 Rue Montebello, Antwerp, Belgium.

removal of suspended matter, is determined by the reduction of opalescence, or better by the diminution of the luminosity of the water under *reflected* light. The river water is rather yellow, and it was noticed that after the first passage this color showed a little increase; but marks at the bottom of the tubes were more sharply defined, so that there was at the same time an increase in color and in transparency. Obviously the better transparency could only be explained by the removal of some of the suspended matter, but what might cause the deepening of the yellow color? If in a colored liquid there are colorless suspended particles, the light they reflect from transverse or side illumination mixes with the axially transmitted light, which gets in this way an admixture of white. When these particles diminish in number, there is less reflected white light added and the color must show deeper, although the liquid is more transparent. The seeming contradiction is thus easily explained. If this reasoning is correct, then when the tubes are placed with their lower ends in a black box, so as to stop all axial transmitted light, the luminosity of the water must depend solely on the side light reflected by suspended particles, and the water must look darker the more these particles are removed. Under the conditions mentioned, the settled river water is very luminous and white, after the first gravel passage it is blue, and it gets darker after each passage; the sand-filtered water and distilled water look black, like ink; they constitute the optically empty space of Tyndall. The effect is very striking and the best way for judging of the removal of particles, but the method does not allow one to state definite figures.

The color in the original water is due to peaty substances and the maintenance of this color (overlooking the seeming increase) shows that these substances are not much affected by one passage through gravel; but generally the samples from the second and third compartments show a small diminution, so that some chemical action is produced. Determination of free and albuminoid ammonia (Wanklyn's method) were made and also of oxidability for "total organic matter" with permanganate (Kubel and Tiemann's process).

There is a very large reduction of free ammonia, however, with variations dependent on speed; and all the compartments have their share in it. So, for example, with a speed of 7 hr.-cm. on the sand filter, the original water with 0.00065 grams of free NH_3, the gravel strainers gave 0.00048, 0.00014 and 0.00065 grams, with a speed of 12, the original water at 0.00096; the second and third strainings gave 0.00048 and 0.000145 grams. Albuminoid ammonia is much less reduced, say from 0.0002 to 0.00012 grams, the action of the first passage being the less marked and sometimes absent. It is the same with total organic matter, the figures in permanganate destroyed being 0.020 to 0.016 grams.

These are the facts. They can be summarized by saying that there is a very marked retention of suspended particles, even of very small size, and also a chemical action on organic matter, especially a marked reduction of free NH_3. Now comes the question: How is all this brought about, what is the theory of the process?

The history of the "dégrossisseur" has been given at some length to show that the system was not the outcome of preliminary scientific considerations. Mr. Puech did not care much for theories, but was very keen on getting good water at the smallest expense; he tried various things and somewhat at random, looking not for reasons but for results. When he got what he wanted he was not satisfied; he tried to enforce the process on the practical hygienist for the water supply. It is, however, impossible for an intelligent being not to reflect on causes and he has framed some explanation of what is going on.

Altogether the idea of attempting to retain the finest mud by gravel and at high speed appears at first sight utterly impossible. The interstices between the stones are enormous in comparison with the size of a particle of clay; it is like sifting sand with a 2-in. mesh sieve. But the clarification is a fact and not only particles of clay, but also microbes, are arrested, the strainers taking out sometimes 90%. In winding their course through the tortuous channels in the gravel, the suspended particles must come in contact with the surface of the pebbles, and if this happens to be dirty and sticky, will be arrested. The comparison is not with a sieve, but with bird lime. Mr. Puech considers that the efficiency of his strainers lies in the multiplicity of contacts; he claims that the whole thickness of the gravel layer is working, while in a sand filter there is only the surface layer. But it is obvious that this last contention cannot be upheld; the layer of sand acts exactly in the same way, and the bacterial retention is the result; we shall later on have the proof.

The general idea of contact with sticky surfaces is certainly correct, but has not been pursued very far in detail; nor is all that is said always consistent with it; for example, the grading of the gravel for "proportioning the size of the meshes to the size of the particles." At a first hearing, this sounds logical enough, but on second thought it does not prove to be so. It would be correct for a sieve; but with apertures say 100 times larger than the particles, it is immaterial whether these spaces are enlarged to 2 or 300.

When we consider the mechanics of sticking, it is clear that the adhesive force or sticking action, in order to retain a particle, must be greater than the actions which tend to tear away this particle and make it move on; these actions are in reality the inertia of a moving body, determinated by its mass, m, and its velocity, v; so that for the "dégrossisseur" working, we must have $S > mv$. It follows that when v increases, m must diminish; the greater the speed, the smaller the size of the particles retained; so that in the first compartment, where Mr. Puech thinks he is straining off the grossest particles, it is in reality only the smallest which are retained. This idea was very forcibly brought to the writer's mind by noticing a reduction of opalescence in a badly conducted experiment, when through a mistake of speed of 500 m. in 24 hrs. [465,000,000 gals. per acre per day] had been given; of course no result was expected, but still there was a good reduction, even for microbes. The straining material was a column of coke 5 m. (16 ft.) deep. The retention is a question of multiplicity of contacts, largely independent of speed.

The samples for chemical analysis were filtered through paper, to do away with all suspended matter, so as to show the chemical action of the passages through gravel on really *dissolved* organic matter. Here any gross mechanical explanation is inadequate; but the possibility of an absorption of such dissolved organic matter of high molecular weight by substances coating the pebbles (an action similar to that of bone-black) must be borne in mind. It is more probable, however, that there is a bacterial action, similar to the nitrification in the soil. When cleaned, the strainers have a marked earthy smell and sometimes there are nitrites in the effluent when the inlet water has none. This would easily account for the removal of the free NH_3.

What is especially striking with gravel straining is the mechanical and chemical efficiency at such speeds. With the sand filter working at the normal rate of 10 hr.-cm., the two first compartments at Waelhem passed 86.4 m. and the third 43.2 m. [270 and 135 ft.]. But this impression results from our mental representation of the quantity as a *vertical* column; if we consider these 86 m. in one day and night as a *horizontal* run, this would mean a very sluggish water-course. At that speed and for a thickness of 0.50 m., the water takes about 3 minutes to pass, so that for the three passages there is a contact with the gravel of not a quarter of an hour.

This preliminary treatment of the water, relieving the filter of much of its mechanical work, must, of course, greatly prolong its life and save cleaning; against this asset, there is the cleaning of the strainer itself. But the cleaning of an ordinary filter must be done with some care, while the strainer may be handled more roughly. In the first strainers constructed, the gravel was placed on perforated iron plates and for cleaning the gravel was worked over under a current of water; at Waelhem the cleaning has been done with a hose and a jet under pressure and this process is simple and efficient. On the whole, it is claimed that for that item the strainers realize a great economy and this seems confirmed by the practice of the several installations. The long run of the filters is especially advantageous in winter time, as there is the possibility of bridging over a spell of frosty weather without cleaning. The greatest saving appears to be in dispensing with settling tanks or decantation reservoirs.

The Suresnes works for part of the suburbs of Paris, which have already been described for the gravel strainers of the system Puech-Chabal, are also interesting for several other peculiarities. Special attention has been paid to repeated and thorough aeration of the water. The delivery of each filter into the next is over a long cascade in three steps, over which falls a thin film of water; the arrangement is simple and efficient, with the available difference of level in this special case. But whether on the whole the result is beneficial, is another question. The idea is to give the oxygen required for the destruction or combustion of organic matter, but such a direct action does not exist, which many years ago induced the elder Frankland to question the obvious fact of the auto-purification of rivers; there must be an intermediary carrier of the oxygen, and plant life plays this part; it thrives on the carbonic acid of the water. By injecting air it is not only oxygen but also carbonic acid which is given, fostering vegetation. One of the bulletins of the U. S. Bureau of Plant Industry at Washington, D. C., mentioned several cases of lakes or impounding reservoirs where attempts to cure a bad smell by injecting air made things worse, because plant growth started again. There is on all the gravel strainers at Suresnes an abundant vegetation, as luxuriant on the fourth compartment as on the first, the stock of carbonic acid, which means food, being at each stage replenished by the cascades. In order to test the correctness of this interpretation, it would be interesting to go through one summer with less water show and cascades, to see whether the growth is not diminished on the last basins. With the experimental tank at Waelhem, vegetation was very troublesome, but appeared mainly in the first compartment; it has been completely stopped by covering over the tank so as to exclude light.

As already mentioned, there are two successive sand filtrations at hourly speeds of 66 and 11½ centm. (16,000,000 and 2,500,000 U. S. gals. per acre per day). There are some curious facts about these two filtrations. On the first filter there is the normal vegetation of algae and diatoms; the effluent contains still a certain number of microbes and its color by transmitted light through a 2-m. (6.5-ft.) tube is more blue than green. On the second filter, the vegetation is poor, scarce, in irregular patches, the bacteria in the effluent are reduced to an extremely low figure, but the color is more green than blue. That last filtration deals the finishing blow to the microbes; but if we judge of the chemical composition by the color, then instead of an amelioration there is a slight increase of organic matter, evidenced by the retrogradation from blue to green. Now this is extremely important. It shows that the two actions of filtration—removal of microbes, removal of organic matter—are not necessarily connected; not only are they here dissociated, but in the last filtration, while removal of microbes goes on, the chemical action is reversed. Still more is to be learned: the chemical improvement is connected with a rich vegetation, the removal of microbes is done by sand alone; the sand acts on the microbes exactly like a gravel strainer. Some years ago the writer had to operate filters with a water in which there was occasional introduction of sea water; there was no vegetation, no blocking of filters, no chemical improvement,

but still good bacterial results. The explanation then framed is completely confirmed by the Suresnes sand filters.

Preliminary sand straining has been applied for several years by Engineer Peter, of Zurich. It seems Zurich is the very place where such a treatment is not wanted, the lake acting as a colossal settling basin; but one soon alters his mind when watching such a strainer being cleaned after a 24 hours' run; when the current of water is reversed and air blown up through the gravel and sand, clouds of fine yellow mud rise and in a couple of minutes the whole tank is a thick liquid. The Zurich plant cannot be considered as strictly sand straining; there are only 30 centm. (12 ins.) of sand, and 60 of gravel, and Peter occasionally calls it "Kiesfilter": i. e., gravel filter. He operates at daily speeds of 50 to 79 m. [47,000,000 to 65,000,000 U. S. gals. per acre per day], and states that the mud penetrates the whole upper layer of the gravel. On the other hand, the preliminary sand filters at Suresnes are not a good example; they have not to deal with the river water, the greatest part of mechanical retention being done by the gravel strainers; and their speed for a preliminary treatment is too low.

Any preliminary treatment must be characterized by easiness and economy in cleaning; what is saved on the last sand filters must not be wholly taken up by the strainers, the capital outlay for the preliminary treatment plant being also taken into account. In settling basins, aided or not by chemical precipitation or a coagulant, the reservoir generally can be flushed or needs only occasional cleaning. The size of the filtering material in the gravel strainers makes the interstices comparatively large, so that rapid clogging is avoided and less head needed; and cleaning is not difficult. Sand being much finer, clogging will be more rapid and more head required to pass a normal amount of water; practice has shown reversal of the current insufficient to clean thoroughly and some rougher mechanical action is necessary; injection of air is an aid, but still Peter at Zurich supplements it by raking.

It is questionable whether sand straining is sufficiently well conducted. In the available literature, there is no mention of any special mode of working or of certain precautions to be taken; the strainers seem to be handled without much care; when cleaned, they are restarted at their ordinary speed, if even they are not hurried on a little to make good for the time lost. With this method, dirt must penetrate rather deep in the filter, so that at each cleaning the whole depth of sand has to be dealt with. If speed was increased only gradually, say during a couple of hours, very likely the strainer would behave much like an ordinary filter, where the surface layer collects most of the suspended material and is alone to be treated for cleaning. Then also a system of mechanical scraping could be utilized; for example, a suction pump on a traveling crane with a telescope pipe flush with the sand; the suction can be so regulated that only a certain amount of sand is taken up. The idea has been suggested by cleaning experimental filters in the laboratory, with a piece of india-rubber hose acting as a siphon. The system will be applied in a filtering plant to supply some of the principal railway stations in Belgium. The same idea has occurred quite independently to some engineers of the Compagnie Générale des Eaux, and an application is contemplated for the filters at Choisy le Roi. Such a cleaning can be done without emptying the filter, in a short time and without disturbing the whole mass of the sand. It is not expected, however, that a complete cleaning can be altogether dispensed with, and this will be effected by compressed air and reversed current.

Another point which deserves consideration is the escape of the washing water. It is essential that it should be able to run away as soon as it comes out of the sand; both its vertical and its horizontal course must be made as short as possible. This means that before cleaning no water must remain above the sand, and that the overflow for the washing must be nearly flush with the sand. The condition of smallest horizontal course is attained by making narrow filter beds, the necessary surface resulting from increase in length. In most American mechanical filters (for example, Jewell) the sand is in a central tank, the rim only a few inches above the sand, and the washing water flows over all round; the condition of smallest vertical course is completely realized. On the other hand, the circle* being the figure of smallest periphery, the condition of the shortest horizontal course is not complied with; but the objection is purely theoretical, the very reduced size of those mechanical filters is practically quite sufficient to ensure a rapid removal. For the long rectangular filters proposed, a gutter will run all along the sides to receive the washing water. The most inconvenient form is a rectangular filter with the outlet in one of the small sides; when such a filter is washed, the overflow soon discharges comparatively clean water, while at the far end the water remains cloudy for a long time.

In most filter beds, the sand is supported on a bed of gravel at least 1 ft. thick, and in several layers; the coarsest below, the finest above. In the filters of the City of Paris proper, these layers of gravel are now replaced by porous concrete slabs 3 ins. thick, made of small gravel with a minimum quantity of cement. There is a reduction in height of at least 25 cm. (10 ins.), a great advantage in installations which cannot dispose of much fall, and also an economy in construction. The porosity is quite remarkable; the water poured on goes through so rapidly that it is difficult to wet the whole surface of a slab. Two objections have been raised: will not the mass get clogged? will not the mass collapse by dissolution of the cement? The two cases are possible. Muddy water will soon put an end to the porosity, but the system is not intended for such waters: there is no fear with a layer of sand and ordinary filtration speed; in preliminary strainers, it is not quite so sure and much will depend on the handling of the filter, on working it so that the mud does not go too deep into the sand. Besides this purely mechanical action from suspended particles, there is the possibility of a chemical precipitate, especially with hard waters; and the reverse with very soft and acid waters, taking up the lime of the cement. In the former case the porous slabs would be transformed into solid stone; in the second it would revert to its original state of a heap of loose pebbles. Most likely such events will be quite exceptional and each case for a water supply must be examined on its own merits. At Paris the system has given complete satisfaction for several years.

Of special interest at present is a visit to the St. Maur filtering station of the city of Paris, on account of an experimental competition for sterilizing the filtered water. Three systems are at work: Treatment with ozone, by Count de Fries (a Dutch nobleman); another by the Otto process; and the Duyk ferrochlore system, the combined action of chloride of lime and chloride of iron. The experiments are on a rather large scale, and part of the cost is defrayed by public money. It sounds rather strange that *filtered* water should be submitted to such a costly after-treatment; but this is a result of the peculiar ideas of French hygienists relating to sand filtration. Another and more potent reason is that something is to be done with the spring water, beautifully bright and clear, but not always above suspicion from a hygienic point of view and ozonization would have the advantage of dealing with this without adding any other material to the water. The final decision will rest with the municipality, and generally electricity appeals to the mind of town councillors. It is possible that an ozonizing plant of some magnitude will be erected for some of the springs. The effect upon the microbes is a well established fact, so little that is new will be learned; but it will be interesting as to cost, the main point on which there is still grave doubt in the minds of many engineers.

The scientific control of filtration presents in France certain peculiarities. As mentioned before, the bacterial analyses are made according to Miquel's method, counting the colonies after two weeks. The information obtained in this way has no doubt a great value, but that is purely historical value; such information cannot be utilized in a practical way to control the work, to push on those filters which give good results, to slow down or even shut off those which are not satisfactory; even the one-day incubation of the ordinary method is long. The ideal would be a test by which at any time the engineer-in-charge could learn by himself or through the resident bacteriologist what is the state of any filter, the results being obtained, say by half an hour's work. What approaches nearest to these conditions is another method of Miquel, a test for *coli*, giving results in 24 hours. But, unfortunately, the interpretation of these results is most singular. The presence of *coli* is considered as a proof of bad working of the filter and of the possible presence of *typhosus* also, and that filter is immediately condemned, its effluent being diverted from the clean water reservoir, only to be used again when during five successive days no *coli* is found.

The ideas about the hygienic signification of the *coli* itself are not always quite clear. Very often the microbe is classed as "pathogenic," because subcutaneous or intraperitoneal injections of cultures are dangerous. The legitimate practical conclusion of these experiments would be: don't take a water containing *coli*, by injections; but the hygienists say that we must not drink such a water, and in this they go too far. A piece of meat may choke a man if it goes in the larynx instead of in the esophagus; the legitimate conclusion is: don't swallow in the wrong way; but it would be obviously absurd to stop partaking of meat altogether. Things must be put in their right place.

During many years, before microbes were known, filtration was conducted in a way which we now would stigmatize as utter negligence; and the results were excellent. Zymotic diseases were kept down. All the improvements added since the eighties and the scientific control show no marked inflection in the statistical curves. The sand filter is hygienically efficient, by itself, and even when not scientifically conducted. From what we know now, we can feel sure that frequently hosts of *coli* must have passed the filters without doing any harm. Now, the supply of large towns, aggregating several millions of people, and during many years, is also an experiment; it is an experiment on a huge scale and with what is still now the best final test for a potable water: the health of the population using it. The mistake of the theoretical scientist consists in discarding this experiment; especially is Miquel a sinner in that direction. There is no profit by ignoring what has been done elsewhere. By making sand filtration more difficult and exacting results which are not claimed from the springs, no useful purpose is served; and, with the best intentions, some harm is done by stopping or delaying sanitation.

In conclusion, the special features of sand filtration in France, as far as the engineer-part is considered, are improvements, and the foreigner can learn a good deal; for what concerns the scientific supervision, it is interesting for its careful and elaborate methods, the painstaking exactness aimed at, the severe claim laid on artificial purification.

[*In many American mechanical filtration plants of recent date rectangular filters are used.—Ed.]

A MILITARY TRACTION ENGINE of special design, the invention of Mr. H. G. D. Wright, is being tried by the British war department. The engine is equipped with a traveling belt on each side, as in the ice or logging locomotive illustrated in our issue of March 14, 1907. The chain on each side passes over four broad sprocket wheels, and has 32 plates 18 ins. square. A 40-HP. gasoline engine drives the shafts of the sprocket wheels by means of gearing. The shafts of the outer wheels have a vertical play so that the flexible chain or wheel-base accommodates itself to irregularities in the ground. The engine has been designed specially for work in rough country, as the result of experiences with traction engines of the ordinary type in hauling guns and wagon trains during the South African war.

A PECULIAR CONCRETE AND STEEL BRIDGE IN FRANCE.

The Annales des Ponts et Chaussées, part 4, 1907, contains an account of a railway bridge across the Guindy, on the line between Treguier and Perros, on the northeastern coast of France, which is notable not only for the peculiar design of the trusses but also for the strange distribution of concrete and steel in the various members that make up the bridge. The structure was erected under the government engineers who prepared the report from which this article has been taken. Unfortunately they were more interested in the stresses in the structure and the method of their computation than in the structural details, which would seem to be the most interesting part of the work. These engineers are so pleased with the success of the design used across the Guindy for an opening of 286 ft., that they have designed a bridge for the Rance, a stream in the same vicinity with a total opening of 541 ft., using the same design. The use of so exceptional a construction for such large spans makes it more than a toy or an experiment, though it is hardly probable that it will seem anything but a curiosity to the American engineer.

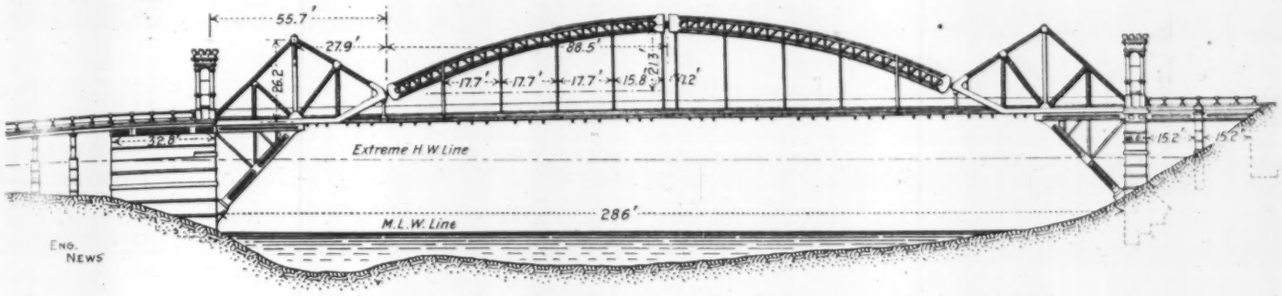


FIG. 1. CONCRETE AND STEEL BRIDGE ACROSS THE GUINDY, NEAR TREGUIER, FRANCE.

From the side elevation shown in Fig. 1 it will be seen that primarily the bridge consists of a three-hinged arch with the haunch hinges some distance up the ring, a common enough design in masonry, but unique, so far as we know, in steel arches. In carrying the stresses from the hinge to the abutment a system is used resembling a distorted king-post truss set on an elbow bracket. The structural conditions existing in this part may be understood from a study of Fig. 2, which is a skeleton layout of the truss. The loads on this truss are the dead and live vertically applied loads between B and E and the arch thrust at E. The reactions are an inclined reaction at B (the vertical component of which

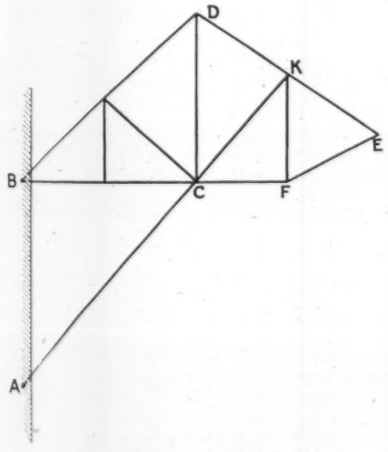


Fig. 2. Diagram of Haunch Truss.

can be found by taking moments around C, and the horizontal component by moments around A) and a thrust at A in line with the strut A C, obtained by taking moments about B. Of these reactions the vertical component at B is negligible, and the thrust at A is the greatest, being about 352,000 lbs. under dead load alone. It is found by the designers that practically all the thrust from the arch is carried down E F to the horizontal B C and the inclined member A C. These members are the main objects of the design; the others are far in excess of their needed size.

The floor system is carried between the two trusses 13.2 ft. c. to c., on the lower chord of the truss and from hangers under the arch. It carries a meter-gage railway track on the floor beam shown in Fig. 5.

In dimensions, the arch rib proper has a span of 177 ft. and a rise of 21.3 ft., and each side truss a length of 55.7 ft. The total opening between abutments is 286 ft.

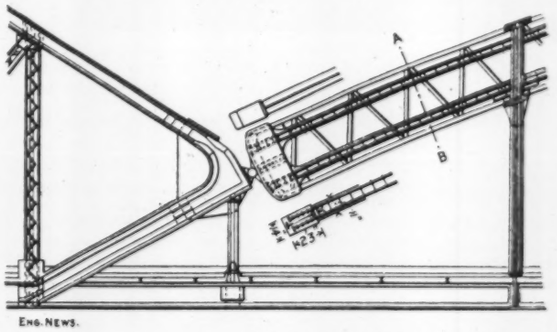
The material used is a curious combination of concrete and steel. All members are of structural steel sufficient, in the case of the working members, to take the dead load, with enough concrete added to take the larger proportion of the live load and also to act as a preservative of the steel. In the truss the heavy members, which it has been mentioned do all the work, are completely encased in concrete, whereas the lighter ones are left unprotected. In the arch the hangers are completely encased in concrete, the floor system left uncovered and the arch rib built as shown in section in Fig. 3. This rib consists of two sets of double flange angles held together with latticing, which carries two rectangular ribs of reinforced concrete connecting, at the hinges, with a section encased in concrete. The abutments are of reinforced concrete built with hollow sections founded on solid rock.

It is figured that, with a ratio of 10 between the modulus of elasticity of steel and that of concrete and a ratio of 1 to 33 in the respective sectional areas of the two materials, the concrete ribs in the arch ring will take about three-quarters of the live load. In this same connection the following rough translation of the original is of interest.

For the concrete-steel members the concrete has been calculated to be able in itself to preserve the continuity in jointed pieces without the aid of metal cover plates, which, however, have been regularly placed. It is easy to demonstrate that in this system the concrete takes all the load and that the steel simply plays the part of a reserve force perfectly protected against atmospheric agents by a strong envelope composed of a matter which is the best preservative of steel. For the arch, the arch ribs of concrete were erected when the metallic arch had already its load and was supporting the weights of the roadway. The concrete, therefore, only carries a part of the strains due to its own load and a fraction of the live load—probably the greater part.

One of the great claims for the design is the ease of erection, with the avoidance of the use of centering. First the truss was erected from the abutment by derricks and then the steel arch ring extended out from the hinge, being held in place by successive guys passed over the crown of the truss at "D" (Fig. 2). The ring was carried forward from each side in this manner until the two halves met in the middle. The floor system was built from stagings hung from the ring as were also the concrete ribs.

The details of construction shown on the figures are not at all complete, but they are the best that we have available and will give a suitable idea of the general principles of the design.



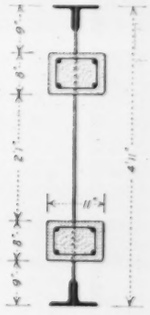


FIG. 3. DETAILS OF RIB AND TRUSS.

A NEW WATER SUPPLY FOR WINNIPEG, Manitoba, to be drawn from the Winnipeg River and to be purified by mechanical filtration, has been recommended by a board of consulting engineers, consisting of Messrs. James H. Fuertes, M. Am. Soc. C. E.; R. S. Lea, of Montreal; J. E. Schwitzer, Assistant Chief Engineer Canadian Pacific Ry., Winnipeg, and Mr. George C. Whipple, Assoc. M. Am. Soc. C. E., New York City. The report of these engineers was dated Aug. 29, 1907, but has just been published. Winnipeg River was chosen after a study of various other possible sources. The scheme provides for an intake above the Seven Portages. The intake and gate-house would have a capacity of about 58,000,000 U. S. gals., and would supply water to a high-duty pumping station, which would force the water over the height of land lying west of Whitemouth River. Three pipe lines would be built, the second and third to be added as needed. The total length of each line would be 294,600 ft., or about 55 miles. For the first 38,500 ft. the conduit would be 45 ins. in diameter if of wood staves, and 50 ins. in diameter if of riveted steel; for the next 26,400 ft. it would be 54 ins. in diameter if of wood and 60 ins. if of steel; and for the remaining 229,700 ft. it would be 48 ins. if of wood and 53 ins. if of steel. Each pipe line would have a carrying capacity of about 27,500,000 U. S. gals per day. At the Winnipeg end of the conduit there would be coagulating basins and mechanical filters. Sulphate of alumina is spoken of as a coagulant. The estimated cost of the work if wood stave pipe lines were built would be $3,862,000 for construction and $343,000 for annual operation, for a daily capacity of 14,400,000 U. S. gals., and $10,519,000 and $1,103,000, respectively, for an ultimate daily capacity of about 58,000,000 U. S. gals. For steel pipe lines the corresponding costs would be well-nigh double, and the yearly operating costs would be $468,000 and $1,474,000. The report contains detailed information on various projects, including many water analyses. The report of the engineers was made to the Water Supply Commission of Winnipeg, of which Mr. J. H. Ashdown is Chairman and Mr. J. M. Miller is Secretary.

THE UNIT VS. THE LOOSE BAR SYSTEM OF REINFORCED-CONCRETE CONSTRUCTION.*

By EMILE G. PERROT.†

It is the purpose of the writer in connection with the subject of this paper to explain how to construct a building with unit reinforcement for columns, beams, girders, floor and roof slabs, or, in other words, how to build a "unit reinforced-concrete building."

To those experienced in the use of reinforced concrete on a large and extended scale, the uncertainty of each beam and girder (where intended to be the same) being constructed identical in a loose rod system, is very apparent; in fact, it is probable that in any building erected under this system there is no one who would certify to the fact that every piece of reinforcement was in the exact position laid out by its designer, and to go further, it is a question whether in a great many cases all the reinforcing metal shown on the drawings actually enters into the construction.

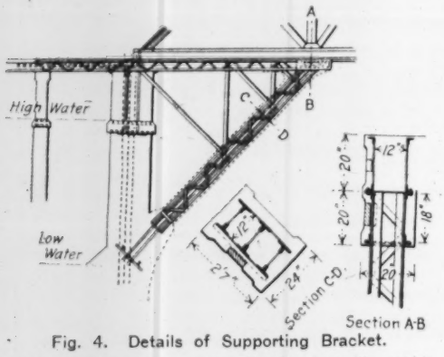


Fig. 4. Details of Supporting Bracket.

Is it any wonder, then, that those engineers whose experience is in steel construction look askance at this new system of construction, when they can see all manner of ways for the finished work to be short of what was really intended. Many such men have advocated the expenditure of a greater sum of money than would be necessary if reinforced concrete were used, for a system of construction which would give results of which they were certain. The writer's experience for the past six years convinces him that if the same progress is made in the future as in the past with the use of reinforced concrete for buildings, the use of loose rod systems for beams and girders must be abandoned. The reason for making this sweeping statement is from the fact that as the building regulation of important cities governing the use of this material becomes more thorough, and the requirements of the Boards of Fire Underwriters are insisted upon, owners will be obliged to employ the more thorough methods of constructing their buildings, or else suffer a penalty at the hands of the Underwriters. To illustrate the point: as a matter of fire protection to the steel tension rods in the bottom of beams and girders, these rods should be located 2 ins. from the bottom of the beam; in other words, there should be 2 ins. of concrete forming an insulation, not ½-in., or possibly 3 ins., as may be the case in a loose rod system. To secure this insulation, some definite means must be used to hold the rods firmly 2 ins. from the bottom of the mold. This is only secured by some positive mechanical means. In loose rod systems the means, as a rule, is altogether wanting, dependence being placed on the concrete for holding the bars in position, or the stirrups are made to form hangers which permit the rods to loosely hang in the form.

If the rods are united into a frame, a suitable chair can be fastened to the bars to support them a definite distance from the bottom of the form. Several systems employ this method. Far better, however, is the use of a socket locking the bars together and bolted to the bottom of the form. This socket can be made to support any number of frames on top of each other, and thus register the position of the bars in regard to their position in the mold as well as to each other.

Another important reason why the rods should be rigidly located in the mold before the concrete is poured is to insure the strength of the beam being the same as that originally figured, for if the bars should be loosely held in the mold, and in the process of tamping be moved farther from the bottom, the insulation from fire would be improved at the expense of the strength of the beam. For instance, in a T-beam with a depth of rib of 16 ins. below the under side of the slab, the loss in strength of the concrete beam, due to the shifting of the bars 1 in. farther away from the bottom, would be almost 7%. Thus, it is seen that when an engineer designs a building with beams of a certain depth and the center of action of steel at a definite distance from the bottom of the beam, there is no certainty that his finished beam in the building has the calculated strength, if there has been no means of holding the bars rigidly in place.

Thus a building can be materially weakened by the inaccuracies creeping in on the work, for if there is a loss of 7% by reason of the bars being misplaced, and another 10% loss, or possibly more, by reason of the concrete not being properly mixed and tamped, the resulting construction, while perhaps appearing to be of the desired strength would be nevertheless weakened and the factor of safety would be reduced.

I have seen a large building constructed of reinforced concrete in which all the floor beams and girders were reinforced with a unit frame, and where these frames were used on the removal of the forms not one bar was exposed to view due to the shifting of the rods. In the same building some unimportant beams in the stairway were reinforced with loose rods, and in one case, after the removal of the forms, a rod was visible, having been pushed out of place in the tamping process. How many other bars have been displaced where the loose ones were used it is impossible to tell.

Thorough tamping of the concrete in the beams and girders is possible only with a frame or where the bars are held rigidly in place. This feature of the work is not always appreciated by constructors, but experiments show that a dense, well tamped concrete is 25% stronger than one not tamped. Hence, there is a decided advantage to be gained by using a frame and thoroughly tamping the concrete.

Another phase of the subject of unit systems versus loose rod systems is that a unit system approaches nearer to ideal conditions regarding the erection of a building, eliminating the personal equation as nearly as can be when the placing of the steel is concerned. No part of the reinforcement of a beam or girder can be forgotten or omitted, as the frames are made as a unit in a shop, given a shop number to correspond to the erection plan, and are delivered to the building as a unit and so marked. All the foreman at the building is required to do is to check off the frames as they are delivered, the same as he would steel beams, and see that each frame is placed in the location called for in the erection plans. Thus a floor of frames can be placed a day ahead of the concrete, and when it is necessary to remove the reinforcement from the form, which is very frequently the case in order to clean out shavings, etc., the frame can be taken out as a whole and reset without much trouble; while, if loose rods are used it is very troublesome to take out each bar and stirrups and reset them.

Some may claim that the use of a frame for reinforcing beams is not desirable on account of a lack of flexibility in the frames; since they are made for a specific beam or girder, they cannot be changed or altered without much trouble. This, however, is not generally an objection, for if a change has to be made quickly at a building, as is sometimes the case, it is not necessary to wait for a new frame to be manufactured and delivered; there is still left the recourse of using loose rods for the beam in question, and the building will be no worse off than its neighbor which is constructed entirely of loose rods.

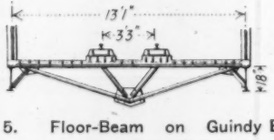


Fig. 5. Floor-Beam on Guindy Bridge.

The flexibility of the design of girder frames as made under the original unit patents is as great as any one could wish. Spans as long as 41 ft. have been constructed of girder frames, and likewise heavy cantilever frames.

Another feature of the unit frame is that it can be made of any type of bar, either plain or deformed; as the bars are assembled and held together by the stirrups, it makes very little difference what the shape is.

The latest idea in the design of girder frames is the pin-connected frame, which consists in making a mechanical tie by means of a link from one beam to another, thus making a continuous beam.

The unit idea has been successfully applied to column construction by several designers. The writer has used a unit column of the hooped type for heavy loads, in which the hooping consists of wire rope wound as a helix wired to vertical rods which are secured to bands at top and bottom at intervals of the height. These columns were made in a shop and delivered by team just the same as a steel column, and set up in position with the forms built around them and then filled with concrete; additional longitudinal rods were placed in the center of the column to increase its compressive strength. All column rods are faced on the ends and set in line with those above.

The unit reinforcement for slabs may consist of any fabric or webbing such as expanded metal, wire cloth, or even plain rods with cross rods on top and together, or fastened together with spring st spacer. These webbings should interlock w rups of the beams and girders. This can having the stirrups long enough to pass up mesh of the fabric and be bent over with lo as to hook over the wires of the webbing. the floor slab cannot separate from the beam and as the greatest horizontal shear is like this place the interlocking of stirrups and f a most excellent construction.

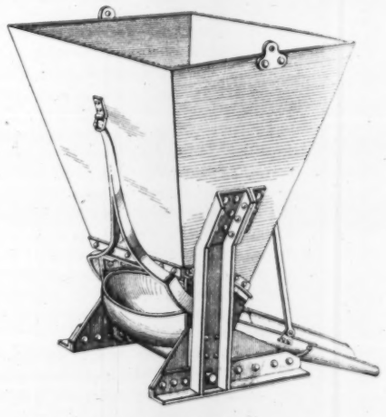
It very frequently happens that the stand fabric do not give sufficient area of metal foot; in these cases additional rods can be w top of the fabric to make up the sectional ar lacking.

Where a webbing is not used for slab re the stirrups should in some manner engage th

A SIDE-DUMPING CONCRETE BUCKET.

In the use of the ordinary bottom dump concrete bucket, there has always been considerable difficulty in controlling the direction and amount of each dump. Especially has this trouble been experienced in narrow form work where generally some sort of a chute has been used in conjunction with the bucket to guide the concrete to its proper place. In order to avoid this difficulty, among others, Mr. A. N. Doud, of North Stockholm, N. Y., has devised and patented the bucket, a view of which appears on this page.

It consists of a pyramidal sheet metal bucket



A New Side-Dumping Concrete Bucket.
(Invented by Mr. A. N. Doud.)

carrying, suspended some distance below the opening in the bottom, a base of structural shapes, which upon occasion may be used for a stand. The vent is controlled by a gate, with cylindrical surface, which covers the bottom opening and turns upon an axle in the base. For narrow form work there is provided a chute, shown in the figure, which catches the concrete from the opened gate and distributes it in amount and direction as desired. In work where it is possible to lay a track alongside of the forms, concrete may be deposited directly from a bucket carried on a flat-car. In the usual bottom dump bucket a derrick must be used to raise the bucket before it can be dumped. For derrick-handled mass work the chute may be removed and the bucket operated as a bottom-dump machine.

A somewhat similar device was described in Engineering News, July 25, 1907, p. 82. The bucket there noted is the invention of Mr. E. S. Belden and was used in the construction of the Montgomery Ward & Co. warehouse in Chicago.

AN INLAND WATERWAY is projected by the State of New Jersey along its coast. It is estimated that by dredging the shallow channels connecting the bays and inland lagoons a continuous inland waterway 100 ft. wide and 6 ft. deep could be made from Cape May to Bay Head at a cost of $278,000. The principal users of such a waterway would be pleasure craft, but there would be some fishing and freight vessels.

*Paper read before the National Association of Cement Users, Fourth Annual Meeting, Buffalo, N. Y., Jan. 24, 1908.

†Ballinger & Perrot, Architects, 1200 Chestnut St., Philadelphia, Pa.

REINFORCED CONCRETE INTERCEPTING AND OUTFALL SEWER, WATERBURY, CONN.

By WM. GAVIN TAYLOR.* M. Am. Soc. C. E.

Waterbury as a city has enjoyed a marked prosperity and development during the past two decades. Since 1900 its population has increased from 51,139 to 74,000. Its general sewerage system comprises a considerable number of relatively small drainage districts, the sewers of which were designed to discharge into the Naugatuck River or its near-by tributaries. The flow in this river is very erratic, varying from less than 50 cu. ft. per sec. to at least 10,000 cu. ft. per sec. During periods of low flow gagings have shown that at times the dilution of the sewage has not been greater than two to one. Fortunately, the river flow is rapid and the Waterbury sewage has had such peculiar characteristics and extreme freshness that putrefaction has never been active in any portion of the river near the city. In fact, putrefaction and the consequent development of mal-odors have not become established until the sewage has reached, and the heavier organic matters have subsided in, the mill pond located three miles below the city. At this point, during the summer months, violent putrefactive actions have occurred, resulting in a marked nuisance through the production of objectionable gases.

As a remedy for these unfavorable conditions sewage purification works have been planned near the said mill pond and the major portion of an intercepting sewer has been completed from a point below the mill pond dam up to the sewer outlets from the city.

The combined intercepting and outfall sewer has principal dimensions as follows: From the site of the sewage purification works to beyond the three main sewer outlets, which are in close proximity, a distance of 2.3 miles, it is of horse-

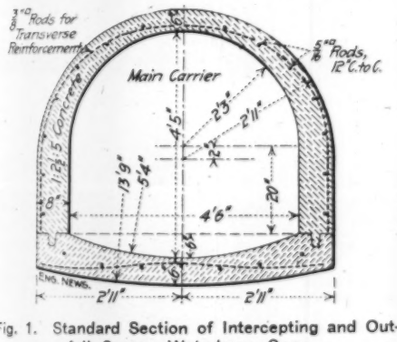


Fig. 1. Standard Section of Intercepting and Outfall Sewer, Waterbury, Conn.

shoe shape, 4 ft. 6 ins. wide by 4 ft. 5 ins. high; beyond this point, and so far as the sewer is now projected, it will have a diameter of 4 ft. The horseshoe-shaped section has a uniform slope of .09%, or a fall of 1 in 1,111. When flowing full it has a maximum capacity of 54,000,000 gals. per day.

Reinforced concrete has been the material used for construction throughout, but the detailed sections have varied widely, owing to the many peculiar governing conditions. On the lower portion of the work, where the main carrier is passing through the location of the sewage purification works, three other conduits, the influent and effluent mains for the filters and a force main from sewage pumps, are put into intimate relation with the intercepting sewer, which passes the entire location of the purification works and by-passes the crude sewage, if so desired, into the river below the mill pond; or the sewer may be used in the future as a carrier of the excessive flow to other purification works to be located further down the valley.

The section shown by Fig. 1 has been the standard form built in open trench work. The covering over this section, has varied from a few feet up to twenty-five and the ground water has put a maximum of 12 ft. head upon the section. Leakage into the sewer has been very small. A section 7,200 ft. long, presenting an interior surface of 106,784 sq. ft., developed a leakage of 0.27 gals. per sec., or a leakage of 1 gal. per sec. for each 400,000 sq. ft. of interior surface. The major portion of this seepage entered through minute cracks developing at bonding points located at the end of a day's

Fig. 2. Wooden Forms and Reinforcement for Outlet Sewer, Waterbury, Conn.

work. These hair cracks were caused by a contraction of the concrete in setting. The bonding joints were of the mortise and tenon type and of such shape as to form a good cut-off against leakage. A few of these joints leaked more than the others and these were cut out by a thin chisel to a depth of 1½ ins. The innermost part of this chiseled groove was then calked with either tea lead, oakum or grouted jute and the remaining portion of the groove filled with mortar and rubbed smooth at the surface.

Excavation for the shallow work has been done principally by hand, while a Lambert cableway was used on the deeper cuts.

Forms for this section have been of wood. The 20-in. vertical side pieces have been braced together by removable cleats, set in place, and the semi-circular arches, hinged at the soffit, have been set upon them. All is readily collapsible. Upon the arches the ⅞-in. lagging has been tongued and grooved to such a bevel as to make the joints radial, and toe-nailed to 2-in. lagging spaced 2 ft. on centers. The lagging is thus free from nail holes on the surface and is planed smooth.

Previous to each use, the wooden forms have been smeared with a low-cost crude vaseline. Fig. 2 shows a section of these forms with reinforcement ready for concrete.

The first cost of wooden forms for this section has averaged $1.80 per lin. ft. and the cost of maintaining them in unexceptionable condition, together with depreciation and fixed charges, has been 12 cts. per ft. of sewer built.

The concrete was mixed in the proportion of 1 part Portland cement to 7½ parts of graded aggregate consisting of coarse sand and crusher-run broken stone, ¼ to 1½ ins. in long diameter. The concrete has been mixed as soft as possible without the separation of free water from the mass, poured into forms so nearly water-tight that none of the mixture could escape, and thoroughly churned—the concrete being deposited in level layers 6 ins. thick.

Three contractors have built portions of this work. The figures given in Table I. fairly represent the composite cost of this section (Fig. 1) of reinforced concrete sewer under the local conditions. The costs given include a general foreman at 50 cts., subforemen at 35 cts., common laborers at an average of 17½ cts., and teams at 50 cts. per hr., but do not include anything for administration expense or contractor's profit.

The sewer line for a distance of a third of a mile is located either along the precipitous slope of the river bank or in the bed of the stream, and throughout this distance the sewer structure has been so located, designed and constructed as to form a foundation for and lower portion of a retaining wall to be subsequently built for the reclamation of a considerable area of low-level lands now subject to flood inundation. The governing conditions were most favorable for the adoption of a design for a dual-purpose structure, and the lands to be reclaimed are of great value for manufacturing uses.

In Fig. 3 is shown the form of the sewer structure, the retaining wall addition and the relative position of high and low water in the adjacent stream. The foundation for this retaining-wall sewer section is 7½ ft. below low water and excavations below the river bed were made in a coarse boulder gravel which forms a most secure foundation for the structure.

The saving in total expense effected through this design is estimated to be, at the completion

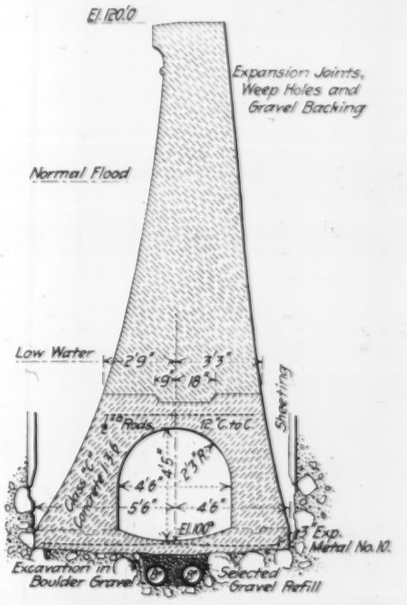


Fig. 3. Section of Outfall Sewer in Retaining Wall, Waterbury, Conn.

of the river wall, fully two-thirds the cost of the present sewer structure.

Manholes entering this section rise from the rear of the structure behind the position reserved for the retaining wall (Fig. 4). The floor of the manhole intersects the side wall of the sewer at the springing line, thus obviating an interruption or eddying of the sewage stream until its surface rises above this point. A similar although more favorable condition prevails at manholes entering the standard sewer section.

Two drumlins were intersected by the outfall sewer and 800 ft. of tunnel was driven through them. The drifts encountered a great range of material, varying from an exceedingly fine sand to a loose mass of small boulders, the principal material being a medium grained sand carrying but a small percentage of moisture. From the nature of this material many difficulties arose in the driving of the tunnels, for it was almost as unstable as granulated sugar and ran freely at the slightest opportunity.

The drifts were 7½ ft. wide by 6 ft. high, in the clear, and were timbered with 8 × 8-in. oak

TABLE I.—NORMAL COST PER LINEAR FOOT OF 53 × 54-IN. REINFORCED CONCRETE SEWER, WATERBURY, CONN.

(Standard section, Fig. 1, containing 10 sq. ft.)

Steel reinforcement, 17¼ lbs.	$0.43
Making and placing reinforcement cages	.14
Wooden interior forms; cost, maintenance and depreciation	.12
Wooden exterior forms; cost, maintenance and depreciation	.05
Operation of forms	.16
Coating oil	.01
Mixing concrete	.30
Placing concrete	.27
Screeding and finishing invert	.08
Storage, handling and cartage of cement	.08
0.482 bbl. cement @ $1.53 per bbl.	.74
0.17 cu. yd. sand @ $0.50 per cu. yd.	.09
0.435 cu. yd. broken stone @ $1.10 per ton	.47
Finishing interior surface	.01
Sprinkling and wetting completed work	.02
Total per linear foot	$2.97

Equivalent to $8.02 per cu. yd.

*Resident Engineer, Sewage Disposal Works, Waterbury, Conn.

side posts, spaced 4 ft. c. to c., and surmounted by 8 × 10-in. oak caps. Side sheathing and ceiling poling boards were of 2-in. oak planks. The tunnels were driven by the ordinary poling-board method. Full breastings were always required for the prevention of slips, and straw was constantly kept at hand for the instantaneous packing of voids and for the filling of cracks between the poling boards and side sheathing. Only

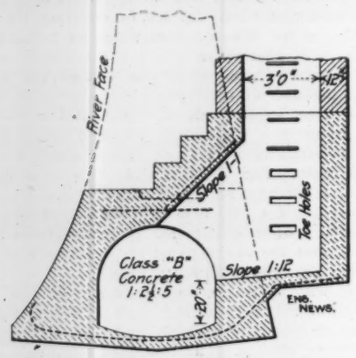


Fig. 4. Typical Manhole in Retaining Wall.

through this method of straw packing could the flow of sand be held in check.

Two gangs, each consisting of two miners and three helpers, were employed at each drift on ten-hour shifts through seven days a week, and they made a total normal progress of 30 ft. per drift per week.

A concrete (slightly reinforced) and brick sewer structure was built within the tunnel drifts. The invert, side walls and 15° of the arch above the springing line on each side is of concrete. Above the skewback thus formed a brick arch was built having a crown thickness of 8 ins. and a thickness of 12 ins. at the skewback.

In one tunnel, that passing beneath a railroad and trestle abutment, the space between the exterior of the arch and the timberings was dry packed with cobbles by hand, but in the other tunnel the backfilling was begun at the center of the hill and worked in both directions toward the portals. In this latter case small openings were cut through the ceiling and sand and gravel were allowed to flow through under guidance, water being applied to the backfilling material as it was deposited. Through the free flowing qualities of the material surrounding the tunnel drift, the arch space was, by this method, closely packed and the void forming above the ceiling worked its way vertically through the drumlin until it reached the surface.

For three-quarters of a mile through the site of the proposed sewage purification works the main intercepting sewer has been built in conjunction with a filter effluent conduit and two pressure mains.

One of the pressure mains is to be used as a force main extending from the site of the pumping station to the septic tanks, while the other is to serve as a filter influent main and is to carry septic sewage under pressure from the septic tanks to the sewage filters. The force main varies in diameter from 24 to 33 ins. and the filter influent varies in diameter from 24 to 38 ins. The effluent main, which will not be operated under pressure, varies in size from 24 to 42 ins. in diameter. The filter influent has its maximum diameter at the upper end and its minimum diameter at the lower end of the sewage works, while the variation in size of the filter effluent is exactly the reverse.

The concrete section forming this peculiar aggregation of conduits varies gradually in general section from end to end, as shown by Figs. 5, 6 and 7.

The plans for the work did not contemplate the construction of the pressure mains in one continuous operation or as a monolith, but rather provided for definite stops in the work at intervals of 40 ft. Provision was made at each of said stops for such expansion and contraction as might occur through variations in temperature and also through the contraction developing during the setting and hardening of the concrete. Each 40-ft. section has been given sufficient steel to ensure the monolithic action of the section and to ensure the concentration of all variations in length to the points provided to receive the same. Longitudinal reinforcement for the pressure mains consists of 5/16-in. square twisted steel rods, spaced as shown in the sections. These rods are of high carbon steel, having a tensile strength of 100,000 lbs. per sq. in. and an elastic limit of one-half this amount. The rods have been received in 21-ft. lengths, bent cold at each end through an angle of 90°, so as to have a projecting leg 1½ ins. long, lapped 12 ins., and wired to the transverse hoops.

The transverse reinforcement for pressure mains consists of ⅜-in. square twisted steel rods of the same quality as the longitudinal rods. They have been spaced so as to permit their receiving the maximum bursting stress with an accompanying elongation of about .03%. Thus the maximum working stress is low in the transverse steel. It was so designed for the purpose of preventing the development of longitudinal cracks through excessive elongation in the concrete.

The transverse rods have also been bent at the ends to form a mechanical bond and then bent to the form of the desired circle, around a series of iron pins secured to a wooden platform. Previous to the placing of the steel for concreting it has been assembled, upon the bank, into the form of a cage (Fig. 8) 40 ft. long and of the required diameter, by men doing this work alone.

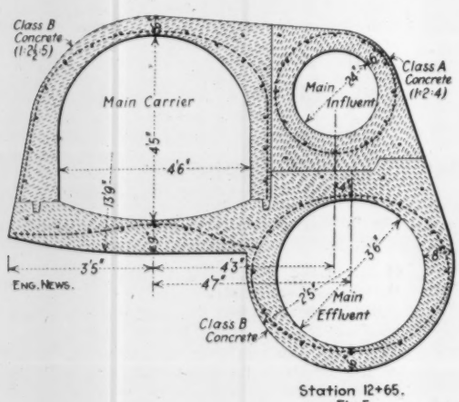
Forms for the pressure mains ha[ve] been of steel, in semi-circular sections 5 ft. length. Forty feet of such forms are fasten[ed] together and used as a unit, being pulled [a]fter the concrete of the previous section [has become] sufficiently set.

At each expansion point a mortise [and tenon] bonding joint of the ordinary type [has been] provided, with the addition of a speci[al] lead cut-off plate. These cut-off pl[ates] formed ins. wide, 1/32-in. thick and weigh[ing] are 12 sq. ft. and are shaped into the form[s] lbs. per Fig. 9. The rear portion of the fla[nge] shown in is embedded into the concrete and the fo[rward] rd portion allowed to project through the [bulkhead] form to be enclosed into the next [succeeding] section of conduit. The cut-off pla[tes] are so shaped and placed that they can read[ily] adjust themselves to such changes in section[al] ngth as are likely to occur.

The pressure pipes and appurtena[nces] s have been covered with wet burlap and kept wet for two weeks after placing. This constan[t] wetness has probably lessened the contraction in the individual 40-ft. sections, for the cracks developing at the expansion joints have been minute in every case.

Pressure main inlets (Fig. 10) leading to individual filters are made water tight by the use of lead cut-off plates similar to those used in the expansion joints (Fig. 9). The manholes for gaining entrance into the pressure mains have been reinforced, and at the top fitted with a cast-iron frame and cover (Fig. 11) secured by means of six ¾-in. double parallel expansion bolts. The joints between the manhole top and the frame and between the frame and cover have been gasketed.

Concrete for pressure mains has been mixed in the proportion of 1 part cement to 6 parts graded broken stone aggregate (gneiss), the particles of which have ranged in size from dust to 1½ ins. in longest diameter. The gradation has been such as to produce concrete of maximum density. The concrete has been mixed by machine to a very soft consistency and placed so quickly that a given 40-ft. section of pressure main would be fully concreted in less than two hours. These pressure mains were designed to sustain, and have been tested under, a hydrostatic pressure of 10 lbs. Under this pressure, with a calculated maximum elongation as stated, no longitudinal cracks have developed in the conduit, and transverse cracks have ap-



Station 12+65.
Fig.5.

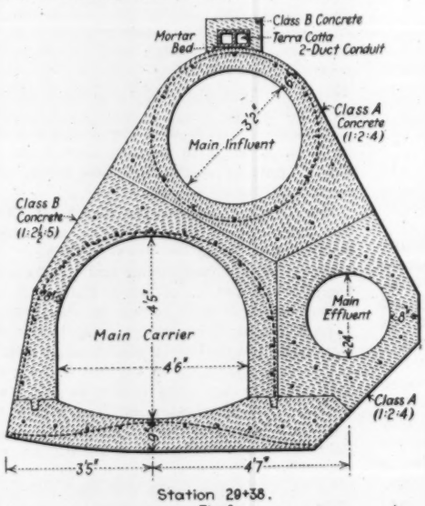


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Fig.6.

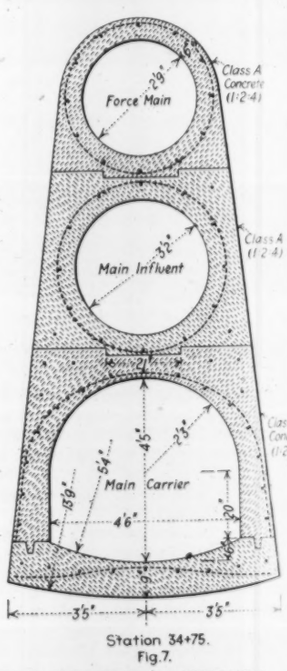

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Fig.7.

FIGS. 5, 6 AND 7. SECTIONS OF COMBINATION OF MAIN OUTFALL SEWER, MAIN INFLUENT AND EFFLUENT CARRIERS, WATERBURY, CONN.

peared only at the points provided for expansion and contraction and at which the lead cut-off plates were placed to secure water tightness.

Table II. gives the representative cost, in detail, for the 24-in. pressure main, the smallest size built. The general conditions surrounding the construction work were somewhat adverse, the scale of wages high and the labor somewhat inefficient owing to the extraordinary local demand. Contractors' profit and administration expenses have not been added.

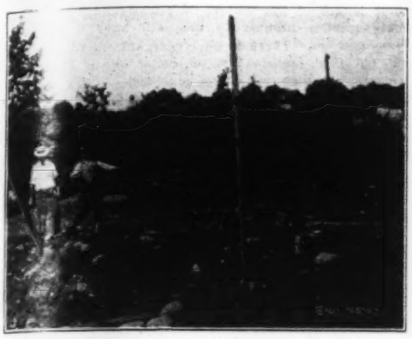

Fig. 8. Reinforcement Cage for Sewer Under Pressure at Waterbury, Conn.

The main outlet sewer running along the bank of Naugatuck River was given permanent protection against the erosive action of the stream through the construction of slope paving (Fig. 12) of two classes, A and B. A total of 7,000 lin. ft. of river bank was so protected, the length of the slope (1½ to 1) varying from 15 to 27 ft.

Slope paving, class A, consisted of large stones having an average depth of 18 ins. and presenting at least one good, even face. The stones were of such shape as to furnish a good bed and a surface joint averaging not more than about 2 ins. The void spaces between the stones were completely filled with small stones, those at the surface being securely driven in and wedged.

Slope paving, class B, consisted of selected glacial boulders. This class of paving was laid on the upper portion of the slope, above the class A paving. In normal depth it varied from 18 ins., at a point where it lies against the lower and better paving, to a depth of 12 ins. at the top of the slope.

The material for class A paving was obtained, principally, by selection from piles of gneiss which had been blasted from deep trench excavations, while that for class B paving was taken from near-by gravel excavations.

Gangs consisting of 1 foreman at 40 cts. per hr., 9 laborers at 17½ cts., 1 hoisting engineer at 25 cts. and 1 A-frame derrick with engine and boiler have, on the average, laid and filled the joints on 29.3 cu. yds. of class A paving in a day of 10 hours at a cost of 95 cts. per cu. yd. The cost of selecting stone from the stone piles, loading upon cars and the hauling of the same, by horses, half a mile, including the trackage cost, has averaged 85 cts. per cu. yd. The total cost of the paving, class A, has therefore averaged $1.80 per cu. yd.

Gangs consisting of 6 laborers at 17½ cts. per hr. and consuming one-sixth of a foreman's time have, in a 10-hour day, averaged 48.6 sq. yds. of class B paving at a cost for laying of 22 cts. The cost of loading and carting the glacial boulders for the work, in single carts, a distance of 700 ft., has averaged 9 cts. per sq. yd. of paving. The total cost of the class B paving has, therefore, averaged 31 cts. per sq. yd.

Three district trunk sewers now enter the interceptor and discharge into it an average daily total of 10,000,000 gals.

The connection between the main carrier and the Washington St. sewer district is shown in Fig. 13, and while it is the smallest of the three present district connections it is typical of all. The district has sewers designed and used on the combined system, and its outlet, having a diameter of 45 ins., enters a sump manhole wherein the coarser grit settles. The dry weather flow passes from the sump manhole through a vitrified pipe connection into the main carrier. Storm water in excess of the capacity of the vitrified pipe connection is discharged into the Naugatuck River through a semi-circular storm overflow so placed as to cause the ordinary outlet to discharge under a head of 1½ ft. before the storm outlet is effective.

As shown by Fig. 13, the storm outlet is provided with a backwater gate, closing upon a concrete gate seat, as a protection against high water in the river, which otherwise would circulate through the storm overflow into the main carrier and thence to the purification works. Such precautions against backwater are necessary until the complete separation of storm and sanitary sewers, as now planned, is effected.

Two district trunk sewers cross beneath the river for connection into the interceptor, and each is encased in concrete (Fig. 14), between 3-in. spruce sheathing, spaced 3 ft. 11 ins. between faces.

Eagle St. siphon (Fig. 15), designed to carry sewage beneath the river, represents the only case where free gravity flow could not be obtained. At the entrance manhole the sewage flow from a 24-in. main, designed to ultimately run half full, is divided and passed through either one, two or all three of the river crossing lines, which are of 10-in. diameter and designed to run full, under a head and at high velocity. The number of pipe lines in use at any time is proportional to the quantity of sewage flowing. In the terminal manholes, it will be noticed that the customary wet wells are avoided and that the sewage stream is divided and arranged for the placing of stop planks to form a dry well. Thus by the control of the entrance any one of the river crossing lines may be cleaned by rods or otherwise while the remaining lines are in use.

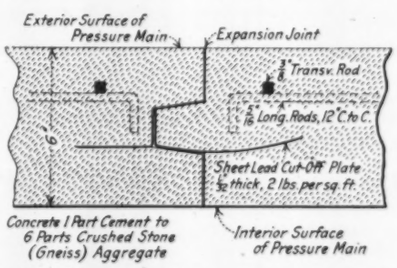
Exterior Surface of Pressure Main
Expansion Joint
⅜" Transv. Rod
⅝" Long. Rods, 12" C to C.
Sheet Lead Cut-Off Plate ⅛" thick, 2 lbs. per sq. ft.
Concrete 1 Part Cement to 6 Parts Crushed Stone (Gneiss) Aggregate
Interior Surface of Pressure Main

Fig. 9. Expansion Joints on Pressure Sewer, Waterbury, Conn.

For convenience and ease in the cleaning and maintaining of the siphon the overflow, the three river crossing lines and the trunk sewer inlet are all capped within the entrance manholes with flap gates, which may be opened or shut from the street level by means of chains, and a 2-in. connection is made with the water main. By filling the manhole to the water service and opening the gate on one of the river crossing lines a pressure of about 13 ft. is put upon the outlet and the pipe line is flushed out under high velocity.

Provision is made within the backwater manhole for preventing the entrance of river water, during floods, into the sewers.

TABLE II.—NORMAL COST PER LINEAR FOOT FOR 24-IN. PRESSURE MAIN.

(Containing 7.26 sq. ft. concrete in section.)

Steel reinforcement, 7.5 lbs.	$0.19
Making and placing steel cages (Fig. 8)	.15
Rental of steel forms	.11
Operation of steel forms	.12
Coating oil	.01
Mixing concrete	.21
Placing concrete	.16
0.422 bbl. cement @ $1.53	.65
Storage, handling and cartage on cement	.06
0.12 cu. yd. sand @ $0.50	.06
0.32 ton broken stone @ $1.10	.35
Concrete pedestals supporting forms	.07
Lead expansion joint plates, labor and material	.06
Sprinkling and wetting completed work	.02
Total per linear foot	$2.22

Equivalent to $8.25 per cu. yd.

The work which has been described is part of the extensive improvements being made to effect the interception of the sewage, the betterment of the sanitation of the river and the final purification of the sewage, and is under the control of the Board of Public Works, with Mr. R. A. Cairns, M. Am. Soc. C. E., as city engineer, and the writer in detailed charge of the design and construction of the work.

Fig. 10. Water-Tight Joint in Sewers Under Pressure, Waterbury, Conn.

THE CONTINUOUS FILTRATION AND RE-USE OF water for public baths at Bermondsey, England (one of the boroughs forming the County of London), was described in a paper by Robert J. Angel, M. Inst. C. E., Borough Engineer and Surveyor of Bermondsey, before the Incorporated Association of Municipal and County Engineers on Feb. 28, 1908. The water from the swimming-pools is first passed through a strainer, then lifted 40 ft. to an aerator on the roof of the building, then filtered, then heated, then again aerated and passed back to the pools. The strainer is a perforated cylinder of copper, so arranged as to be easily removed and cleaned. The first aerator consists of three perforated zinc trays supported on A-frames. The filter is of the mechanical type, but is operated without a coagulant. The filter tank is 6½ × 14 ft. in plan × 5½ ft. deep. This gives a filtering surface of 91 sq. ft., which is said to be sufficient to deal with 20,000 Imp. gals. per hr. Such a rate would be about 575,000 U. S. gals. per 24 hrs., or 275,000,000 gals. per acre per day. The filtering material is described as "gravel of special quality," 18 ins. deep. The heater is supplied by waste steam from the pumps and other parts of the building, and raises the temperature of the water from about 50° to 74° F. The filter is cleaned "about every second or third day, by passing about 2,400 [U. S.] gals. of water and live steam the reverse way through the filtering media." The paper states that the first and second-class baths are worked alternately and that the water in the large swimming-pool is renewed every 4½ hrs. The cost of the filter installation was well under $5,000. The author states that the saving in water bills the first year by means of the filter was about $900. Water costs about 10 cts. per 1,000 U. S. gals. The physical appearance of the water, after nine months' use, is satisfactory, and both chemical and bacterial analyses also indicate that the filters and aerators keep the water in good shape.

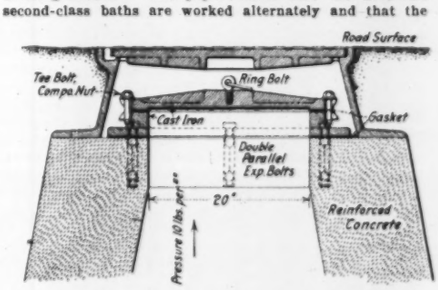

Fig. 11. Manhole Cover for Pressure Mains, Waterbury Sewerage System.

THE FUTURE POLICY OF RAILWAYS WITH REFERENCE TO TIE SUPPLY.*

The number of ties used annually for renewal and construction purposes by American railways has been steadily on the increase for a number of years, and during the last year some 118,000,000 ties were used for renewal purposes alone. This represents a serious drain upon the forest resources of the country. Attention has been called to the decreasing supply of standing timber by numerous writers for some 15 years or more, and especially so during the last five years. Warnings have been issued from time to time calling attention to the fact that unless something were done the railways would be confronted with a serious problem as to their supply of ties. While these warnings have been increasing in insistency, very little, if any, heed has been paid to them. This has probably been the case not because the railways did not realize that there was a rapidly decreasing supply of timber available for tie purposes, but because in spite of the decreasing supply little difficulty has until recently been experienced in getting the requisite number of ties at fairly reasonable prices. During the last year or two, however, this condition has changed very materially. Prices of ties have gone up with startling rapidity and, in many instances, it has been almost impossible to obtain the necessary number of ties of certain kinds of wood and of certain quality, even where the highest prices were paid for them. One of the eastern roads has made a standing offer of 85 cts. for white oak ties 7 × 8 ins., 8½ ft. long, and has been able to obtain only a very small percentage of the number needed for its construction work. White oak, which used to be the standard tie timber, has become so scarce that, with the great demand for it for other purposes, resulting in its increased value for lumber, the prices for white oak ties have in many parts of the country gone to a point where it is no longer economical to buy them for tie purposes.

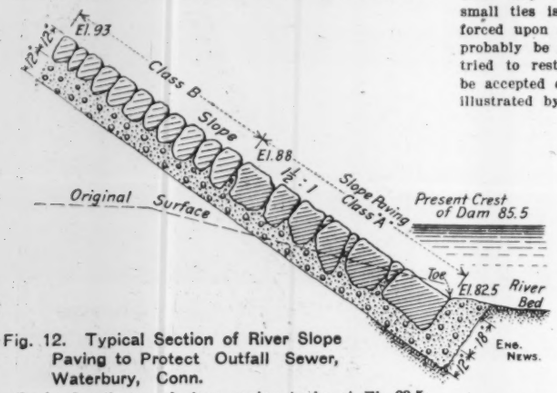

Fig. 12. Typical Section of River Slope Paving to Protect Outfall Sewer, Waterbury, Conn.

(In hard soil, toe of slope paving to be at El. 82.5; in soft soil, toe to be carried down to a firm foundation. Embankment to be made of surplus material from trenches.)

1. ENCOURAGING METHODS FOR THE MORE ECONOMICAL CUTTING OF TREES.—The object of the railway is to assure itself that a certain definite number of ties will be available annually, and that the source from which these ties will come will be a definite one. One of the most important methods which can readily be followed at this time will consist in the adoption of proper regulations in the contracting and purchase of ties, particularly from forest lands located along the right-of-way, and to see to it that every tree which is cut for tie purposes yields the greatest possible number of ties which such trees are capable of producing. By economical methods of cutting, we mean that trees should be cut as low as possible on the stump and as high as possible into the tops. Examples of wasteful methods of cutting can still be found in practically every tie camp throughout the United States.

The waste which takes place in the cutting of hewn ties when compared with sawed ties is likewise a matter which demands the most careful consideration. It will frequently be possible to saw ties from crooked trees and from tops which would be left in the woods by the maker of hewn ties. It will be impossible to obtain any marked success in the way of improving the character of the cutting unless all the railways buying ties in certain territories agree to buy them under similar specifications.

2. ENCOURAGING METHODS FOR CUTTING ONLY THE MATURE TREES.—It is frequently the practice in cutting over a given tract of forest land for tie purposes to cut any and all trees which might possibly make a tie. Most railways today use ties 6 × 8 ins. by 8 ft. Ties are being made which are very much smaller. These are offered on regular contracts and are generally admitted as seconds or culls, and where they are not offered to the railways they are sold to street railways and others using smaller ties. These small ties come from two sources: 1, from the tops of trees, and 2, from small trees not large enough to make a standard pole tie. Second class, or cull ties, are accepted on contracts by railways at the present time to a varying number because most companies are so anxious to get ties that they are willing to accept ties under size which they intend to use largely for sidetrack work and secondary lines. It is true, however, much as we would like to deny this, that many of these small ties find their way into first-class track. The acceptance of small ties is something which the railways believe is forced upon them and which most managements would probably be glad to do away with. Many roads have tried to restrict the number of small ties which will be accepted on tie contracts. That this can be done is illustrated by a number of the lines in the Mississippi Valley territory, who refuse to accept more than 5% of ties under size and who rigidly live up to this requirement.

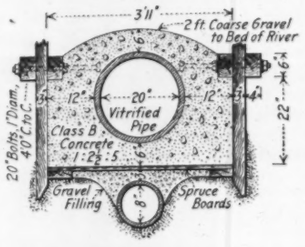

Fig. 14. Typical River Crossing for District Sewers, Waterbury, Conn.

The Committee believes that this matter of the acceptance of small ties is one of the most important subjects for consideration with reference to a future tie supply. The objection will be made that it is impossible to buy ties at the present time without accepting a certain per cent. of small ties. It should be stated in answer to this that the railways must face one of two alternatives; they must either insist on getting only full sized ties (refuse all but the very smallest percentage of small ties, namely those which would be cut from tops of trees); or they must face the certainty that they are rapidly depleting the oncoming stock of tie timber by permitting young trees to be cut for second-class and cull ties, which, if allowed to grow, would in an appreciable number of years make standard sized ties. The cutting of trees which will make only second-class ties not only gives ties which are not serviceable, but at the same time cuts off the possibility of a future supply.

The critical period from the time when a tree is large enough for a second-class tie until the time when it would make a first-class tie, is only five to ten years. Second-growth white oak in order to grow from a tree 8 ins. diameter to 10 ins. diameter requires ten years. Chestnut requires only eight years, and the same would probably be true of timbers of the red oak [illegible]

3. THE USE OF TREATED TIES.—Ties [illegible] bought in such large quantities at the present [illegible] because the service obtained from them in the [illegible] rarely exceeds six to seven years. The railroads therefore renew one-seventh of its ties every year, with the increased expense of new ties, to which must be added the expense of renewal and the cost engendered by the disturbance made in renewing ties, tie renewals become more and more costly every year. Where ties are treated chemically with any of the well-known preservatives their length of life will be increased and a correspondingly smaller number of ties will have to be bought from now on. There is no longer any question that the chemical preservation of ties is one of the greatest economies which could be practiced. There should be no reason why every railway should not treat its ties, and that at once. Every tie which is treated this year means one tie less which will have to be bought six years thereafter. The reduction in the number of ties which will have to be bought after the use of treated ties has once been adopted will depend very largely upon the kind of preservative used and the manner in which the work of preservation has been done.

The use of a preservative which will give three times as long as the present one is far preferable to one which will only double the length of life. The saving of a small amount at this time by the use of an inferior preservative will be very insignificant ten years hence when the obtaining of ties at any price will far outweigh the small saving at this date.

4. THE EMPLOYMENT OF METHODS LOOKING TOWARD THE REDUCTION OF THE MECHANICAL WEAR ON TIES.—This subject really forms part of the preceding recommendation, because increasing the length of life against decay should go hand in hand with increased length of life against mechanical abrasion. It will be found inadvisable to so treat a tie chemically that it will resist decay 20 to 25 years when such ties wear out in 12 years. One of the most urgent needs at this date, therefore, leaving out of consideration entirely its influence on general track construction, deals with the problem of increasing the mechanical service of ties. It should be possible to so protect treated ties that they will serve 30 years, admitting now that it is no longer impracticable to preserve for 30 years by chemical treatment.

An excellent precedent has been established in this respect on the French railways. The French treat beech timber with creosote and obtain an average service of 25 to 30 years using mechanical devices for reducing the wear on such ties in addition to treating them with creosote. A beech tree grows so as to make at least four ties in 120 years; that is, by the time treated beech ties are no longer serviceable a new crop of beech trees has grown in the forests, yielding a sufficient number of ties to replace those which have gone out of service.

5. PURCHASE AND MANAGEMENT OF FOREST LANDS.—There is assurance that a definite number of ties each year and from a definite source, can be obtained by the purchase of existing forest tracts by railway companies and the management of such tracts in such a manner that the number of trees cut for tie purposes each year will be equivalent to the amount of wood which grows on such lands each year. In order to effect such a policy railways will have to purchase very extensive tracts of timber land and hold these indefinitely. The requirements of a tree species for tie production on such forest lands have recently been well stated as follows.

1. It must furnish a tie, which, at least when treated, will give continuous service for from five to eight years, otherwise the expense of frequent renewal will make it too costly. 2, It must not be so valuable for lumber that it cannot be cut for ties. 3, It must be of rapid growth, in order to attain a suitable size in a short time. 4, It must renew itself easily after cutting, so as to maintain the forest without much expense.

Forest lands on which grow tree species which would fill such requirements are still available in many parts of this country, but their acreage is very rapidly de-

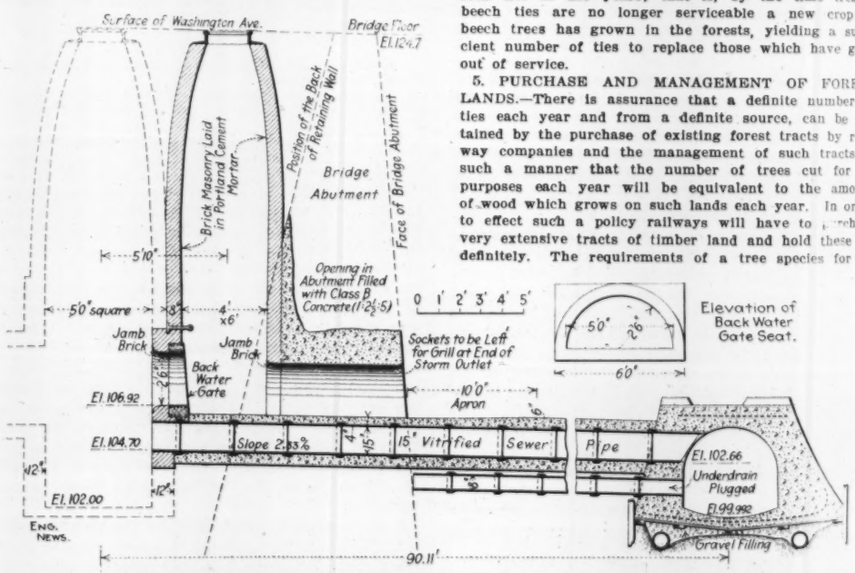

FIG. 13. LONGITUDINAL SECTION THROUGH WASHINGTON AVENUE CONNECTION WITH MAIN OUTFALL SEWER.

*From the report of the Committee on Ties, presented at the annual meeting of the American Railway Engineering and Maintenance-of-Way Association at Chicago, March 17-19, 1908.

crossing, and the timber which might serve for a future tie supply is rapidly being reduced because of the present methods of cutting any and all trees on any given tract. Where lands are to be held, they will have to be bought very soon if any plan of management is to be adopted.

Examples of forest management in this country are unfortunately almost completely lacking and where they do exist they are of such recent character that very little can be learned from this source. The Norfolk & Western Ry. has recently decided to follow a plan of forest management. Quoting from a report of the Chief Engineer:

It has been decided: 1, That our lands be managed as pine forest lands, but that any hardwoods at present be allowed to remain until reaching merchantable size. 2, That no attempt be made to raise catalpa trees on this land. 3, That a scheme of forest management be devised for the proper handling of the forest properties of the railway, so as to improve same and also so that they may yield revenue. 4, That no timber be sold from the tracts except after an examination of the land and determination of the actual value of the timber present, and also not until proper restrictions are placed on the party cutting the timber.

Similar plans have been made by the Delaware & Hudson Ry., owning extensive tracts of forest lands in the Adirondacks, and by the Northern Pacific, owning forest tracts in the Northwest. In this connection it may be well to state that it may prove desirable for railway systems to invest in forest lands not immediately situated along their lines. Such lands should preferably be selected in southern states, where the rate with which timber grows far exceeds that in the northern states. The possibilities of forest management are well shown by an example dealing with loblolly or North Carolina pine. In a recent report on the loblolly pine forest as an investment for tie purposes in southeast Texas by Mr. Zorn (of the U. S. Forest Service), he finds that in East Texas the forest proper yields from 200 to 400 or occasionally 500 ties to the acre, but the average per acre for a section of land is 70 to 80. After a study of the number of ties produced by trees of different diameters and of the rate with which such trees increase in diameter, he finds that the average stand of loblolly pine is ready to be cut when it is about 40 years old. "At earlier ages the growth is more rapid, but the trees are not large enough to be available for ties, while after that time the annual rate of growth falls off."

It appears from an estimate, which seems reasonably conservative, that an investment in loblolly pine lands will produce 80 ties per acre for an indefinite period of time on a rotation basis of 40 years, and that an area of 500,000 acres will be necessary to produce 2,000,000 ties per year. An investment in this acreage would mean a definite supply every year of 2,000,000 ties and where these are chemically treated the company owning such lands would be able to supply its own demands for a number of years and after that would be able to sell practically this entire number annually to other companies not so fortunately situated.

In addition to loblolly pine, rapidly growing species of native forest trees which will deserve consideration are members of the red oak family, red gum, sycamore, chestnut, shortleaf pine, beech and possibly spruce and balsam. The rate with which these species will reproduce themselves is not definitely known, but, estimating loblolly pine at 40 years, most of the others will require as long or longer. The longer the rotation period, the more land will be required to obtain a sustained annual yield. This will, of course, vary considerably with the regions in which the forest tracts are located, and it is not possible to give any definite figures which will hold good generally. The conclusion to be drawn from this discussion is that the purchase and management of forest lands is not only possible but eminently desirable at this date. Railways having forest lands on their lines and even those not so situated should investigate the possibilities of engaging in management of lands for tie production.

6. THE PURCHASE OF CUT-OVER LANDS AND PLANTING OF TREES FOR TIE PURPOSES.—The last consideration with reference to a future tie supply is the one which appeals most strongly at first sight to the persons interested in obtaining a future tie supply; viz., the subject of tree planting. Many railways have from time to time made experiments looking toward obtaining ties by planting various species of trees. Most of these experiments have, however, been failures to a greater or lesser degree for various reasons. The idea was to get rapidly growing trees, irrespective of their fitness for tie purposes, their susceptibility to insect and fungus attack, etc. In most cases the work of planting and caring for these trees was done by men wholly unfamiliar with trees and tree care.

As a result of this unsatisfactory condition the Pennsylvania R. R. this year appointed a forester whose function will be to devise ways and means for managing tree planting work which that railroad is engaged in. This railroad is now following a distinct policy. The planting of locust trees on a large scale has been discontinued. During the last year there were planted 252,154 red oak trees, 175,516 black locust, 6,970 European larch, 4,570 pin oak, 3,500 Scotch pine, 3,000 tamaracks, 2,316 chestnut. These trees were selected on account of their moderately rapid growth and because all of them, with the exception of chestnut, are adapted to creosoting. As far as possible, each species is planted on soil to which it is best suited. Pin oak and American tamarack are being used on wet situations, where better trees would not thrive. Quoting from a report of the forester.

It is impossible to state definitely at present the number of acres available for tree planting, since these lands include some 25,000 acres of watershed which are already partially timbered, and many farms which have been acquired in connection with the construction of new low grade lines or in straightening or widening the main line. On the average, the trees have been spaced 6 × 6 ft. apart, or about 1,200 to the acre, and in all cases nursery stock alone has been used. We plan, however, to experiment with direct field planting of acorns and chestnuts; but this is likely to be unsatisfactory, owing to the destruction of the seeds by rodents. In the past, most of the nursery stock has been purchased from commercial dealers, but in the future we intend to grow most of our own nurseries. Since the land on which the planting has been done is to be held for railway purposes, in any event, we have not charged its actual cost against the returns. As a general proposition, however, I would say that a maximum of $10 per acre would be a fair valuation and leave a fair balance of profit over the present cost of ties. Assuming our land is worth $10 per acre, the cost of planting and material, annual taxes of 3 cts. and annual charges for maintenance of protection of 15 cts., we have the following expenses per acre at the end of 40 years:

Cost of land at $10, 4½% for 40 years	$58.16
Cost of plant material and planting, $10, at 4½% for 40 years	58.16
Taxes, 3 cts. per acre, at 4½% for 40 years	3.21
Management and protection, 15 cts. per acre at 4½% for 40 years	16.05
Cost of sawing or hewing 400 ties at 10 cts each.	40.00
Cost of hauling 400 ties at 5 cts each	20.00
Total	$195.58

On the above estimate, all ties would be produced at an average cost of about 48 cts. each, which would be a saving over present prices for red oak and chestnut of about 4 cts. per tie, in addition to paying a 4½%

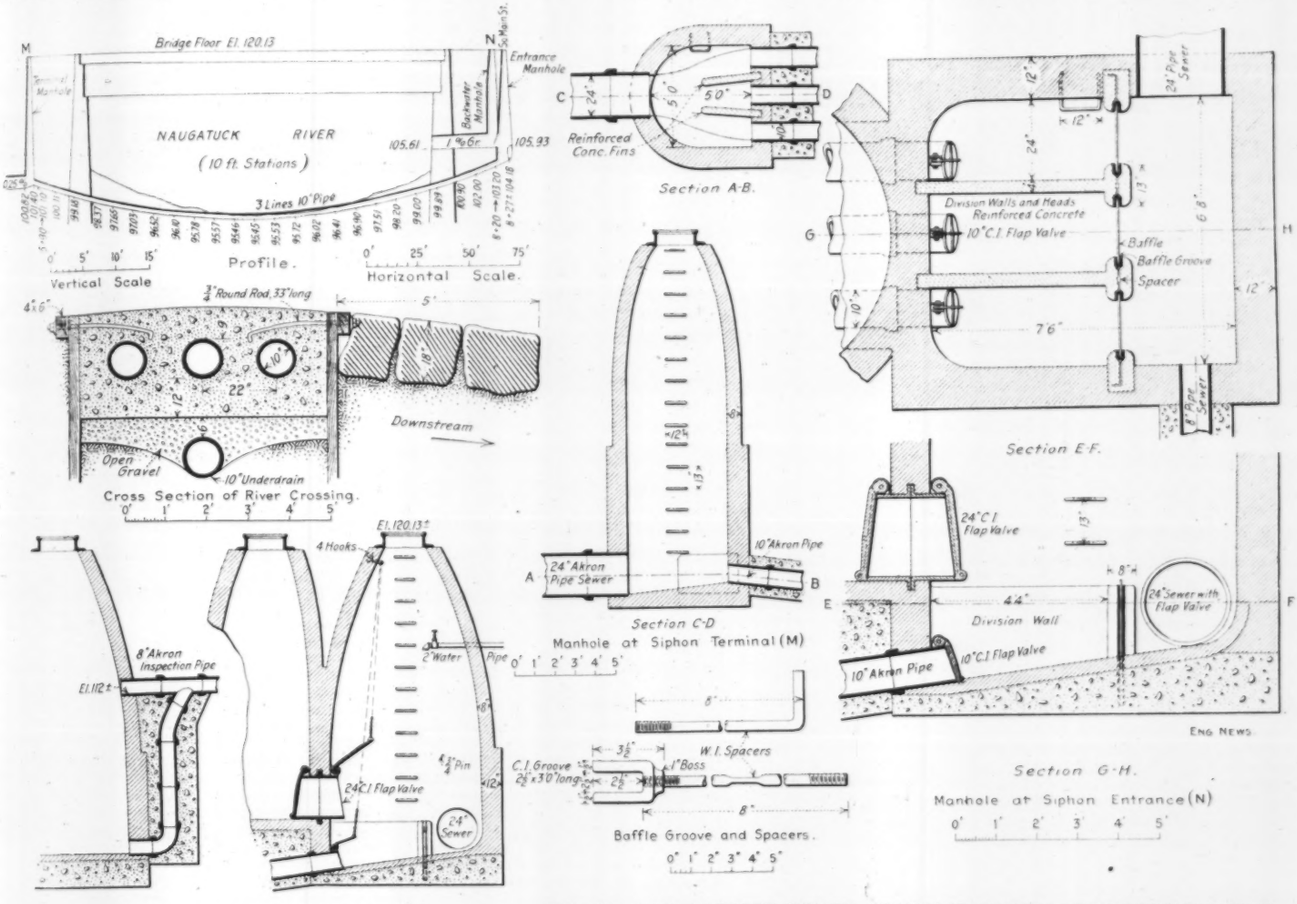

FIG. 15. EAGLE STREET SIPHON, SEWERAGE SYSTEM OF WATERBURY, CONN.

interest on the investment. The estimate of 40 years from planting to maturity will hold for red oak and most of the pines, while chestnut should mature in 30 to 35 years. The trees at the end of this period should average about 15 ins. on the stump.

The Chicago, Burlington & Quincy Ry. about a year ago started planting catalpa trees. The following account of this planting is given by this company:

In May, 1906, we planted about 112 acres with one-year-old catalpa trees on land near Pacific Junction, Ia., valued at $75 per acre, which, prior to that date, had been leased for an annual rental of $3.00, representing 4% on above valuation. Adverse circumstances, such as poor soil conditions at time of planting, and a most destructive hailstorm which occurred this summer, have so damaged the 78,125 trees that almost two years' growth have been lost, so that we may say the grove has only just started.

Further planting of trees has been deferred for two or three years, in order that the development of this grove might be watched and some conclusions as to probable results be reached, before incurring additional expenditures. It is estimated that at the end of ten years, half of the trees will have to be cut out, so as not to retard growth, and should produce at least 420 posts per acre.

At the end of 20 years the trees are expected to have grown to such size as to produce 420 ties per acre, 420 posts per acre, besides cordwood amounting to 1½ cords per acre. At the end of 20 years it is estimated that the total outlay, including interest on investment, will amount to $219.30 per acre, and the probable revenue may be summed up as follows:

420 ties at 60 cts.	$252.00
420 posts at 5 cts. (cut at 10 years), and 5% compound interest on revenue from same for 10 years	34.20
420 posts at 5 cts., cut at 20 years	21.00
Cordwood	3.00
Total revenue per acre	$310.20
Total estimated outlay	219.30
Net revenue per acre	$90.90

The net revenue shown above is based on present prices of material and labor. It is probable that this would be absorbed in the product of ties, etc., resulting in a correspondingly less unit cost.

The Louisville & Nashville Ry. started planting three years ago, using catalpa speciosa, black locust, yellow poplar, Russian mulberry and walnut. They consider this as an experiment. Black locust, poplar and walnut are being grown in Kentucky. Catalpa speciosa has been planted in several plantations, the largest being at Carney, Ala., at which point 1,000 acres were purchased for the special purpose of raising these trees. The railway company states as follows:

The results thus far accomplished are not such as to enable one to give specific information as to the cost, probability of success, etc. Our idea has been not so much to provide cross-ties for our future requirements as to encourage the owners of vast denuded areas in the South to follow our lead and utilize their lands for the same purpose. Nevertheless, if the result of our work should prove satisfactory, we will enlarge our plantings so as to eventually provide for all, or a substantial portion, of our requirements.

It is claimed for the catalpa speciosa that it will grow in any soil and under almost any conditions, but our experiments have not as yet progressed to a point sufficient to confirm or refute this claim. We estimate that, with proper care, the trees should mature, so as to furnish three or more ties per tree in 19 or 20 years. The black locust will hardly be of value except for fence posts, as the growth is extremely slow. We have planted something over 1½ million trees, and expect to continue planting until we utilize all of our available lands. The lands at Carney were acquired at a cost of $5 per acre. We have planted about 300 acres, and 200 additional acres are now in course of preparation. The price of black locust varies, according to size, from $1.50 to $5 per 1,000; yellow poplar about $5 per 1,000. We have expended to date approximately $30,000, exclusive of the cost of the land.

The Atchison, Topeka & Santa Fe Ry. has recently purchased a large ranch in southern California for the purpose of raising eucalyptus trees for tie purposes. During the last year about 750,000 trees were planted. Owing to the newness of this experiment, it is not possible to give any detailed figures.

The general conclusion which the Committee has come to is that the planting should be regarded as supplementary to other methods for securing a tie supply, particularly to the management of forest lands. The selection of grounds for planting trees will be a difficult matter in many respects, because in regions where trees naturally grow rapidly, lands will be found too valuable for agricultural purposes. It will therefore be necessary to turn to denuded forest tracts or to forest regions. With the latter alternative, it seems very much more advisable to buy forest regions, or where cut-over lands are purchased, to encourage the growth of the natural forest trees, rather than to go into extensive experiments for the planting of new trees.

7. THE IMPORTATION OF TIES FROM OTHER COUNTRIES.—While the available tie supply of most countries is not very large, conditions may be such as will make it possible to obtain considerable numbers of ties from various countries. That this can be done has recently been illustrated by contracts made for Japanese oak, elm, ash and pine ties, which are being imported by two railways on a large scale at the present time at prices about equivalent to the highest prices now being paid for white oak. Various kinds of hardwood ties have from time to time been imported experimentally from South American countries and from Mexico and Central America. There are large quantities of pine available in the mountains of Mexico, and a detailed examination of the forest resources of many of the South American republics would doubtless show large quantities of timber which could be obtained should this become necessary. The ties which would come from such timbers, however, would consist mostly of very hard timbers, necessitating a different system of handling with respect to rail fastenings than is customary at the present time.

One of the present objections to counting on timbers in South America and adjoining countries is the difficulty experienced in cutting and logging these timbers, generally located at a distance from the seaboard, which would necessitate very expensive operations, resulting in a very high first cost for these ties when landed in the United States. The same is true for such excellent tie timbers as karri and jarrah, species of eucalyptus grown in West Australia. The large forest resources of Canada may at some time become available. It is pointed out, however, that while these foreign sources of supply may be considered, they are but remote factors when compared with the possibility of assuring a definite supply within the territory of the United States.

CLEANING WATER INTAKE PIPES FROM SEDIMENT at the New Claiborne Station of the New Orleans Railway & Light Co., New Orleans, La., is effected in a novel and interesting manner by a plant recently installed for the purpose. At this station four 72-in. intake pipes have been extended through the Mississippi River levee to supply the condensers. Water jets, controlled by valves, have been provided for at 10-ft. intervals in the bottom of each intake. When the pipes are to be cleaned of sediment the jets are first operated to loosen the deposit and the deposit is then flushed out by the pump discharge. The pump is an Allis-Chalmers screw pump designed to give a flow of 8 to 10 ft. per sec. through the pipes. It is driven by a 700-HP. 550-volt induction motor. In the design and construction of the power station, Messrs. Sanderson & Porter, of New York City, served as engineers.

RAILWAY YARDS, WAREHOUSES AND FREIGHT HANDLING MACHINERY.*

FREIGHT YARDS FOR HUMP SWITCHING. The number of groupings that can be made to advantage is generally large; it follows, therefore, that a large number of comparatively short tracks in a classification yard will be more satisfactory as to results, than a smaller number of longer tracks that will hold full trains, increasing the number of classification tracks to the limit of available room, or to the greatest number that can be thought desirable or necessary, the cost of operation of the yard will not be greatly increased, but the efficiency of the subsequent movement will be diminished by the better grouping that permits continuous movement and prompt delivery at destination.

The use of gravity in assorting cars has long been recognized as a rapid, economical and efficient method. Where the local conditions as to grades are favorable for gravity switching, it has been found desirable to introduce humps or elevations, with steep grades descending therefrom, over which cars may be run to the tracks provided for the classification or groupings desired. On the general proposition as to the desirability of gravity switching for separating and assembling cars, there is little difference of opinion, but as to details, height of hump, ratio of grades, location of scales and velocity that should be given to cars, we find widely divergent views. The grade approaching the hump should not be greater than that of the main track over which the trains to be classified have been hauled by one engine; and at the hump there should be only sufficient excess grade to bunch the cars at the head end, thus making it possible to promptly uncouple each cut as desired.

If the classification tracks are long, and cars are classified in both directions, it will sometimes be considered as too expensive to establish ideal grades through the classification yards. We may assume that such ideal grades would be 0.4% to 0.5% after leaving the ladder tracks. It is also probable that various local conditions (such as the location of engine houses, coaling stations, car repair shops, etc.) may govern distances available for the accelerating and ladder grades. Therefore it will not often be possible to so harmonize all factors as to secure ideal conditions throughout. To so construct a hump that the greatest number of cuts of cars may be classified over it, the steepest part of the grade must be reached in the least available distance after passing the summit of the hump. In his way the cuts or groups of cars for different tracks may gain speed, and separate quickly, thus making the necessary interval of time between cuts for the operation of the switches without unnecessary delay to the movement.

The summit of the hump should be reached by vertical curves that raise the grade about 1 ft. in a distance of 60 ft. The curves should have a radius of about 1,500 ft. The curve beyond the hump should have a length of about 30 ft. from the highest point, and join a grade not exceeding 2% passing over the scale. The scale should be located on the hump in cases where the proportion of the cars to be weighed is relatively large. In other cases, a special scale track should be provided beyond the hump, and so arranged as to make it convenient to return the cars for reclassification by gravity. In the first case it is desirable that a track scale not exceeding 60 ft. in length should be placed on the descending grade in the main hump track, about 30 to 40 ft. from the summit of the hump. With this arrangement all cars passing

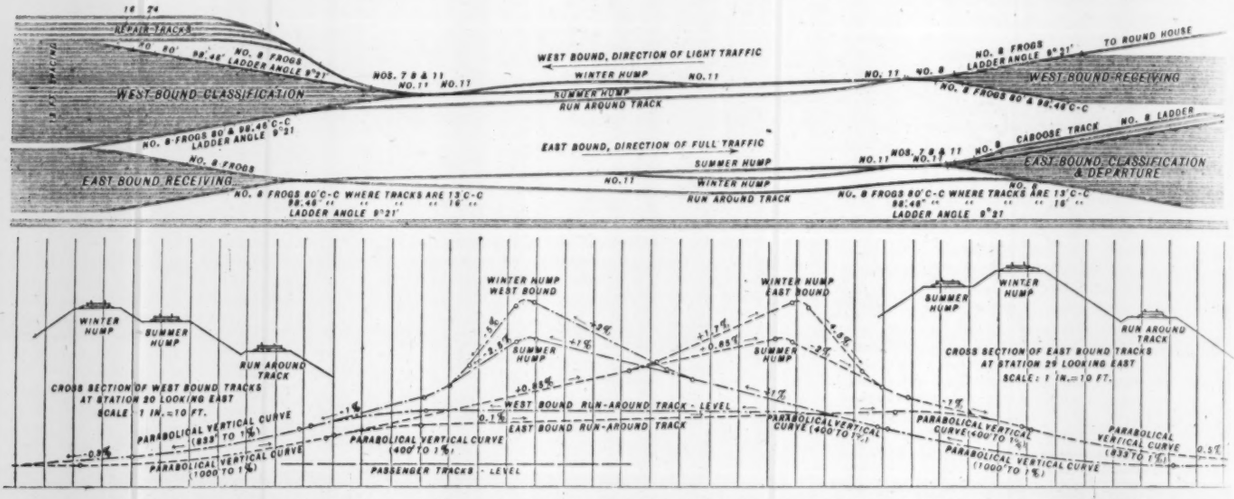
WEST BOUND, DIRECTION OF LIGHT TRAFFIC
WEST BOUND CLASSIFICATION
WINTER HUMP
SUMMER HUMP
RUN AROUND TRACK
WEST BOUND RECEIVING
EAST BOUND, DIRECTION OF FULL TRAFFIC
EAST BOUND RECEIVING
EAST BOUND CLASSIFICATION & DEPARTURE
CABOOSE TRACK
TO ROUND HOUSE
WINTER HUMP WEST BOUND
WINTER HUMP EAST BOUND
CROSS SECTION OF WEST BOUND TRACKS AT STATION 20 LOOKING EAST
CROSS SECTION OF EAST BOUND TRACKS AT STATION 29 LOOKING EAST
WEST BOUND RUN-AROUND TRACK - LEVEL
EAST BOUND RUN-AROUND TRACK
PASSENGER TRACKS - LEVEL

FIG. 1. PLAN AND PROFILES OF YARD HAVING SEPARATE SWITCHING HUMPS FOR SUMMER AND WINTER USE.

*Abstract of the report of the Committee on Yards and Terminals, presented at the annual meeting of the American Railway Engineering and Maintenance-of-Way Association, at Chicago, March 17 to 19, 1908.

over the ... up may be weighed if desired, and with the least pos... e delay, trouble and expense.

To over... ne the very serious objection to the ordinary installatio... of track scales with dead track, one rail of which is ... rried on cast-iron standards, it is proposed to substi... for such standards a continuous wall of reinforced ... crete provided with openings for the scale levers. ... has been proved by actual experience that it is possib... to successfully operate track scales on a 2% grade. ... curate results can be obtained from such scales, a... it is not difficult to maintain them on a grade. It has al... been found by actual practice that scales located on ... e hump track do not decrease to any appreciable exte... the number of cars handled over the hump per hour. It has been suggested that no dead rail is needed on a scale placed in the hump track, but it must be remembered that the accuracy of a scale depends very largely upon the sharpness of its bearings. As these bearings wear, the scale becomes slow in action and the beam will indicate weights proportionately light or below the actual weight. Therefore it is not advisable to run over the scale any cars that are not to be weighed. If the weights are desired only for billing or engine rating, it is desirable that the scales be equipped with automatic registers, to save time and permit more rapid movement.

In evidence of the fact that the installation of track scales on steep grades is considered good practice, it may be stated that many scales are installed in tracks where the grade is from 1.5% to 3.5%, and as the commodities handled are sold by the weights thus obtained, it may be assumed that the grade does not seriously interfere with the accuracy of results. A scale located on a grade of 3.5% is used to weigh the product of a large stone crushing plant; the results obtained are satisfactory. As to the rapidity with which cars may be weighed we have evidence as follows: (1) Nine cars have been weighed in one minute on a scale 60 ft. in length; (2) the weighing of seven cars per minute is often accomplished; (3) the weighing of 150 cars per hour is common practice with a grade of 1.3% over the scale and the cars running by gravity at a maximum rate of about ten miles per hour. With the installation proposed by the report, the cars would leave the scale at a speed of about 6½ miles per hour.

To overcome adverse conditions and secure satisfactory working in cold weather, it has been found desirable to increase the height of humps sufficiently to give the cars a velocity of about 20% in excess of that required for satisfactory working in warm weather. Where the conditions of traffic and the changes in temperature warrant the expense, a marked advantage in expediting movements may be obtained by providing the hump with two parallel tracks, one having the required grades for summer work and the other having the grades for winter work. Such an arrangement is shown in Fig. 1.

It is generally conceded that after passing the hump, cars should be given the desired velocity and should reach the classification tracks in the least distance in which satisfactory results can be accomplished. It is therefore desirable that the ladders be doubled. It is suggested that the grade be made 4% beyond the 2% grade over the scale, giving the cars a speed of about 14 miles per hour when entering the ladder tracks. The grade of the ladder tracks should be 0.8% to 1.0%, so that this speed may not be reduced until after the classification tracks are reached. If this speed is considered excessive it should be reduced by eliminating all or part of the 4% accelerating grade.

Where cars to be classified are largely empty or light, and the scale is on the hump, grades are recommended for average conditions as follows: The summit of the hump should be reached by vertical curves with radius of about 1,500 ft. that raise the grade about 1 ft. in a distance of 60 ft. The curve over the summit to be continued on the descending grade a distance of about 30 ft. to join a grade not exceeding 2% for a distance not exceeding 60 ft. Thence descending by a vertical curve with radius of about 2,000 ft. a distance of 40 ft.; thence descending on a grade of 4% a distance of 50 ft.; thence descending by a vertical curve with radius of about 5,000 ft. a distance of about 155 ft., to join a grade of 1% at the heads of the ladder tracks. Thence down through ladder tracks and turnouts, 1%; thence down through classification tracks, 0.5%.

Where cars to be classified are largely heavy or loaded, and the scale is on the hump, the same grades are recommended for use over the hump as for light cars, but as the proportion of light cars diminishes the length of the grade of 4% may be reduced. It is recommended, however, that the length of the 4% grade be at least 25 ft.; that the grade of ladder tracks be at least 0.8%, and that the grade of classification tracks be at least 0.4%, where conditions permit. When required by traffic conditions, a track scale not exceeding 60 ft. in length should be located at such a distance from the summit of the hump (30 to 40 ft. is recommended) that when cars to be weighed reach the scale they will be properly spaced from following cars and will be running slowly enough to easily secure correct weights. The grade over the scale should not exceed 2%.

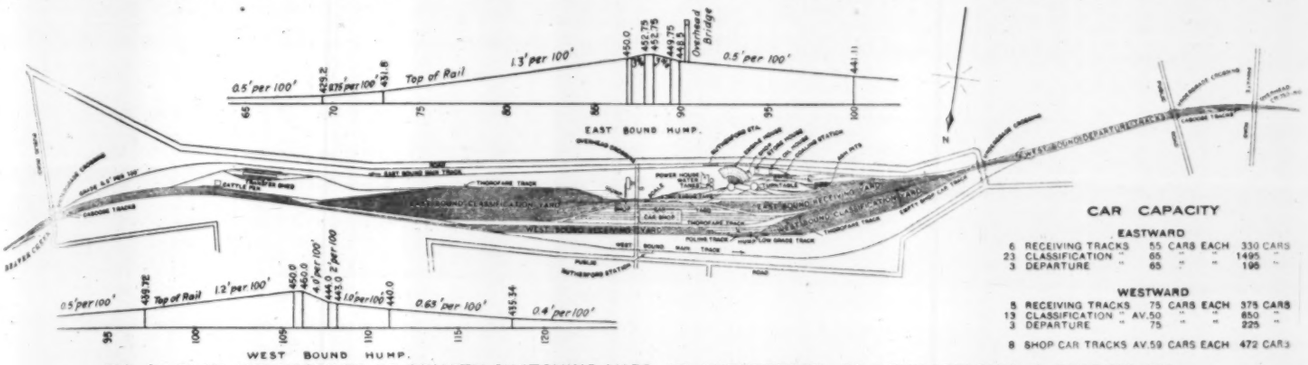
EAST BOUND HUMP.
WEST BOUND HUMP.
Top of Rail
1.3' per 100'
0.5' per 100'
1.2' per 100'
0.63' per 100'
0.4' per 100'
Overhead Bridge
CAR CAPACITY
EASTWARD
6 RECEIVING TRACKS 55 CARS EACH 330 CARS
23 CLASSIFICATION " 65 " " 1495 "
3 DEPARTURE " 65 " " 195 "
WESTWARD
5 RECEIVING TRACKS 75 CARS EACH 375 CARS
13 CLASSIFICATION " AV.50 " " 650 "
3 DEPARTURE " 75 " " 225 "
8 SHOP CAR TRACKS AV.59 CARS EACH 472 CARS

FIG. 2. PLAN AND PROFILES OF GRAVITY SWITCHING YARD AT RUTHERFORD, PA.; PHILADELPHIA & READING RY.

THE RUTHERFORD YARD, PHILADELPHIA & READING RY.—The Philadelphia & Reading Ry. has a hump yard of recent construction at Rutherford, about five miles east of Harrisburg on the Lebanon Valley branch. This is shown in Fig. 2. The yard is located on a summit, with original grades of 0.5% descending both east and west from a point about midway between the location of the humps. The road is double-track and the original center line passed approximately through the center of the yard, but in the relocation the main tracks were placed outside, with ample room allowed for extensions of the yard. On account of very heavy excavation, a large portion of which was limestone, it was not thought advisable to make the cutting deep enough to take full advantage of the almost ideal conditions as to grades that were presented at the location. Therefore the grades of the eastward classification yard were made somewhat heavier than desirable, with the result that more car riders are required than would otherwise be needed, and the use of brakes is imperative to prevent excessive speed. There are 23 tracks provided for eastbound classification and 13 for westbound classification. Nearly all frogs in yard tracks are No. 8, and in main tracks No. 10. For a period of 30 days the results have been as follows:

	Eastward.	Westward.
Cars passed over hump in 30 days..	36,750	33,400
Cars passed over hump in 24 hours.	1,520	1,390
Cars passed over hump in 1 hour...	93	104
Average cuts per train.....	21.7	20.9
Car riders employed.....	35	23
Switchmen	8	6
Percentage of cars weighed.....	39	20
Total cost per car handled through yard	0.137	0.098

Cars moving eastward are nearly all loaded, and a large percentage of them are steel cars of high capacity. On account of the mixed condition of trains on arrival, and the wide distribution and large number of groupings to be made for delivery at destination, the cuts average about 1.5 cars per cut. The westward movement consists largely of empty coal cars that must be grouped for delivery to three connecting lines. The through loaded cars are grouped in the same way, and the grouping of cars consigned to large industries and deliveries within the switching limits of Harrisburg require the use of the remainder of the tracks available for westward classification. The cuts average about 1.6 cars per cut. Cars that require repairs are cut out at the hump and are dropped on to tracks parallel with the ladders, from which they are taken by switching engines and delivered on the shop tracks properly grouped as to the character of the repairs to be made. Cars of merchandise to be transferred, stock to be fed and watered, and cars to be held for any reason, are cut out at the humps in the same manner and placed on proper tracks until ready for further movement.

TRACK SCALES.—Scales longer than 60 ft. are rarely used, and many that were longer have been reduced to 60 ft., as the very long scales are slow in action and expensive to maintain on account of the additional number of levers. The length of platform is generally about 36 to 46 ft.; 24 ft. on ore roads with short cars, and as high as 60 ft. in some cases. The Philadelphia & Reading Ry. uses 60-ft. scales for weighing coal and freight cars, these scales being on the switching hump. The practice of stopping cars on the scales is not desirable or necessary, except when weights are to be obtained with extreme accuracy. As a rule a track scale will not give exactly the same weight for a car that is weighed repeatedly, so that little (if any) gain in accuracy results from stopping cars on a 60-ft. scale. When scales with 60-ft. platforms are built to weigh long tons and hundredweights, and when cars are spaced at least 60 ft. apart, a good weighmaster will get correct weights at speeds up to at least ten miles an hour. This is being constantly done, and with satisfaction to both buyer and seller.

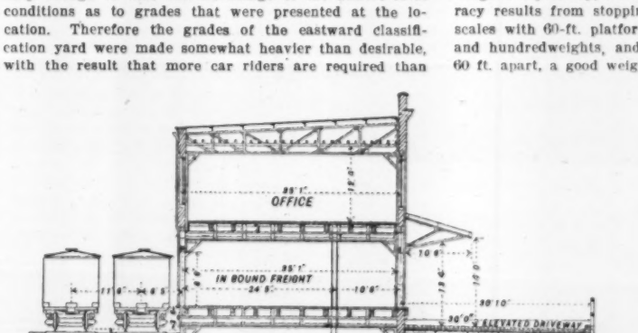

FIG. 3. CROSS-SECTION OF DOUBLE-DECK FREIGHT HOUSE.

CONVEYING CAR RIDERS IN HUMP YARDS.—One of the important points to be considered in the operation of hump yards is the method of bringing the car riders back to the hump. A locomotive with car has been used, but is not an economical or satisfactory equipment for the purpose. At the Collinwood yard of the Lake Shore & Michigan Southern Ry., electric trolley cars are used. The yard was not constructed for this purpose, and one of the switching tracks about the center of the yard had to be taken for the use of this car. It runs to the base of the hump, but is not allowed to foul any of the switches down the hump. Its longest travel is about 1,500 or 1,800 ft., and it plays back and forth almost continuously; the riders catch on wherever they may find it most convenient by walking to the center track opposite where they last stopped a car. This reduces the total amount of walking about one-half. The car is speeded to a maximum of about 20 miles per hour. It is considered very successful, and the general yardmaster thinks it will save two or three men at times when each hump ordinarily employs about 15 riders. A moving sidewalk for carrying the car riders has been proposed for the Gardenville yard of the New York Central Lines.

A gasoline motor car for the return of the car-riders has been used at the Galewood yard (Chicago) of the Chicago, Milwaukee & St. Paul Railway. The results have not been satisfactory, as the car has many weak features. These could be remedied, and the car would then be more desirable than a locomotive for this purpose, on account of the economy in operation. At present a small locomotive is used, this being fitted with a footboard at the side, for the men. The cost of maintenance of the motor car and the locomotive for 12 hours is given as follows:

	Motor car.	Locomotive.
Engineman	$2.40	$2.40
Fireman	...	1.80
Coal, 1½ tons at $2.10	...	3.15
Water, one tank	...	.50
Gasoline, 13 gallons at 11 cents	1.43	...
Total	$3.83	$7.85

YARD LIGHTING.—At points where work is concentrated, or the movement is rapid, more light should be provided than where the tracks are straight and movement generally slow and in one direction. Under the latter conditions the distance between lamps may be increased to such spacing as is found necessary to keep cars clearly visible at all times within this distance. To minimize the effect of shadows, the lamps should be placed at such a height as will produce the best results, and reflectors should be used to prevent the blinding effect on the men and to concentrate the light where most needed. The form or shape of the reflectors will vary according to the location of lamps and the directions in which the illumination is desired. As a rule the reflectors should be so placed as to throw the light downward and outward and in the direction of the movement rather than against it, and so as to make the flames of the lamps invisible from approaching cars, except at short distances.

The power of the lamps governs their spacing to a very great extent, but lamps of lower power with closer spacing will produce a better diffusion, and be therefore more generally satisfactory as to results, than lamps of higher power and wider spacing. The higher the lamps are placed, the greater the diffusion, and the less illumination at the level of the ground, and therefore the less effect of shadows. It follows, therefore, that where the most light is required the lamps should be hung low and the spacing should be close enough to supply the light needed.

It is generally thought that lamps of nominal 2,000 c. p., placed at a height of not less than 28 ft. above the ground, are most efficient, and that the radius of illumination should be taken as 2½ times the height. This gives a spacing of 140 ft. for the lamps if a high degree of illumination is required. This, however, is more than is needed for classification tracks and it is recommended that for yard purposes the lamps be hung from 28 to 40 ft. high, and that with the necessary reflectors they be spaced 150 to 300 ft., according to the amount of illumination required. The unit system of lighting from towers 100 to 150 ft. high has much to recommend it for yard illumination. By the use of lenses and reflectors the light may be utilized to a much greater extent than is possible with lamps that are hung closer to the ground, and intense shadows are avoided. A voltage greater than 500 should not be used.

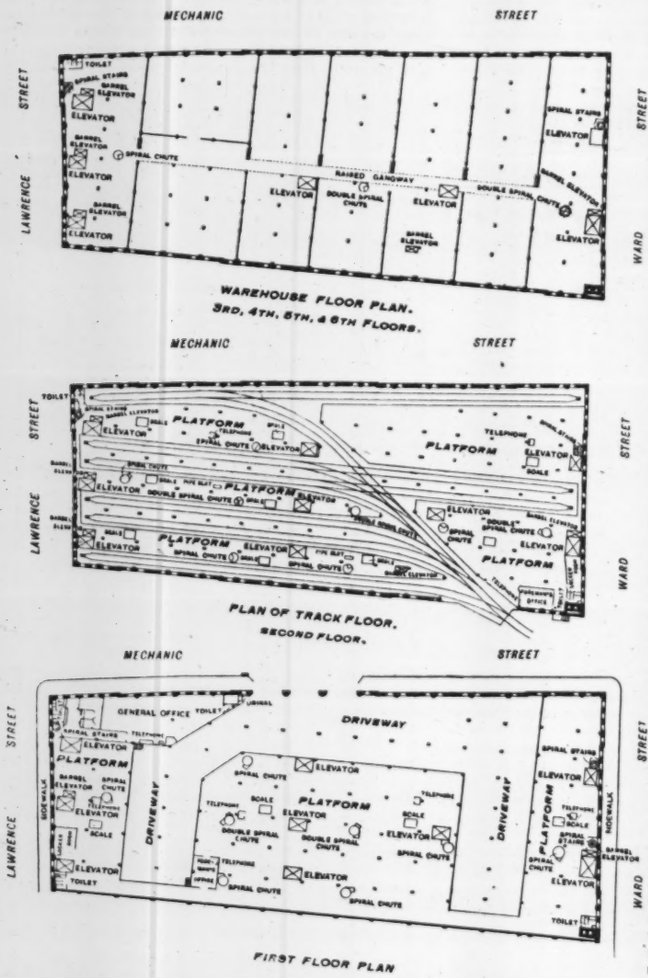

FIG. 4. PLANS OF RAILWAY FREIGHT STATION AND WAREHOUSE AT NEWARK, N. J.; NEWARK WAREHOUSE CO.

RAILWAY FREIGHT HOUSES AND WAREHOUSES.—Ordinary freight houses have been dealt with in earlier reports, but a class of railway freight warehouse which is now coming into use is that which combines railway and commercial purposes. Facilities are provided for cars and teams, and other portions of the building are rented to merchants and others. Thus inbound freight can be sent direct to storage, and outbound freight sent direct to the car platform for shipment. This arrangement saves considerable time and also eliminates much of the heavy trucking, or teaming, between freight houses and private warehouses, which causes congestion in city streets. The business is of course under control of the merchants' city offices by letter, telegraph and telephone. The requisite space is afforded by a number of stories, as the areas of sites available are usually both limited and expensive, and special facilities must be provided for the prompt and ready handling of freight. The warehouses of the Newark Warehouse Co. (Central Railroad of New Jersey) and the Pittsburg Terminal Warehouse & Transfer Co.* (Pittsburg & Lake Erie Railway), are examples of this class of freight warehouse.

Double-deck freight houses, with tracks on two or more floors, are rarely used, but may be found to have important advantages where very small sites on city property of high value must accommodate a heavy business. In fact, the design of freight houses in large cities should include full consideration of methods of operating cars and teams on at least two levels. Freight received on the upper floor can be delivered to platforms (for cars or teams) on the lower floor by various devices. In the same connection, consideration may be given to the utilization of other floors for storage or warehouse purposes, as noted above. The track and team floors may be reached by inclines and elevators, the cars being handled on the track floors by capstans and [illegible]. This is done in several cases in Europe, [illegible]ever, the ordinary freight cars are very much smaller and lighter than in this country. The double arrangement was the special feature of a freight [illegible] signed about two years ago for the Chicago of the Pere Marquette Ry., but this was not [illegible] outbound freight was to be handled on the [illegible] at the street level. The inbound freight was [illegible]dled on the upper floor, having an inclined [illegible] the tracks and an elevated team driveway from [illegible] St. to the Polk St. viaduct. The space available [illegible] very limited, lying between the Grand Central [illegible] and the freight house of the Chicago Great [illegible]

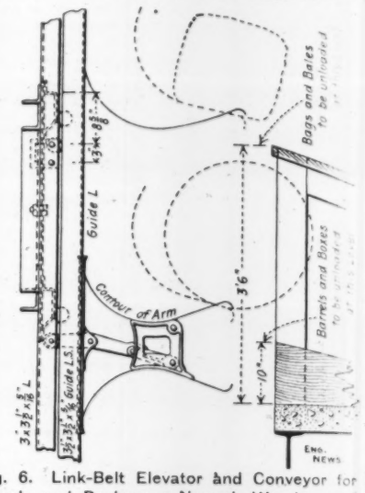

Fig. 6. Link-Belt Elevator and Conveyor for Barrels and Packages; Newark Warehouse Co.

Ry., and separated from the latter by a 50-ft. driveway. The end frontage was on Harrison St., and the building was to be about 35 ft. wide and 800 ft. long. The general arrangement is shown by the cross section in Fig. 3.

FREIGHT-HANDLING MACHINERY.—Machinery for conveying and elevating freight is largely used at factories and commercial warehouses, but its application in railway freight houses is as yet very limited. This is in part due to the variety of sizes, shapes and weights of the packages to be handled, but there is no doubt that economy in time and cost can in many cases be ensured by the introduction of freight-handling machinery. Most of the numerous builders of conveying machinery have apparatus of this kind, among which may be included the following:

(1) Platform elevators.

(2) Chain elevators, with arms for barrels, sacks, boxes, etc.

(3) Inclined elevators or conveyors, having continuous platforms or belts, or chains with arms.

(4) Spiral chutes for descending freight; having a spiral sheet iron platform.

(5) Spiral and inclined chutes for descending freight; having a floor formed of rollers.

(6) Horizontal conveyors, having chains with arms, a continuous platform or belt.

(7) Telpherage systems, with motor trolleys running on an overhead rail or carrier, and picking up packages or trucks.

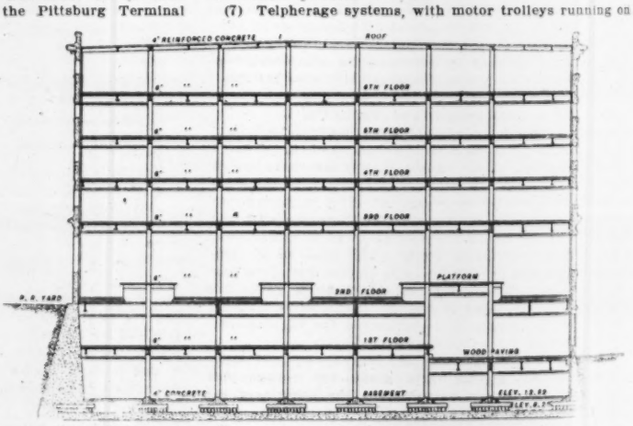

FIG. 5. CROSS-SECTION OF RAILWAY FREIGHT STATION AND WAREHOUSE AT NEWARK, N. J.

The materials handled include bags, sacks, barrels, packing cases, rolls of wire, bundles of steel [illegible] and

*Engineering News, July 19, 1906.

wire, at boxes of all sizes. One firm states that for the horizontal distribution of freight in freight houses and similar places it has designed a system which would allow small cars to be loaded at the various receiving doors and pushed on a slight down grade onto a main distributing track where the car would be taken up by power and carried around a circuit having switches, to other sidetracks opposite the car-loading doors. The operation would be entirely automatic, as the car would carry mechanism for switching it onto any of the sidetracks desired, making it unnecessary for any man to follow the freight about in distributing it. The cars in question would carry trucks for running the freight into the various cars when desired, or could carry the freight laid on them bodily. For handling freight in warehouses having a number of floors, it uses the same principle, tray elevators discharging the packages to any floor for which the discharge mechanism may be set by the man placing the freight on the loading arms.

The telpherage system, with motor-trolley carriers running on an overhead rail, is in use by the Old Dominion Steamship Co. at Richmond, Va. It is used for handling heavy cargo and for coaling the steamers, but for general cargo trucking is employed as being the more economical system. The overhead runway extends between the wharf and the railway storehouse and cars. The system handles 3-ton loads in special trucks which can be wheeled to and from the points reached by the overhead line. Installations of this kind for railway freight houses have been planned, but none have been built.

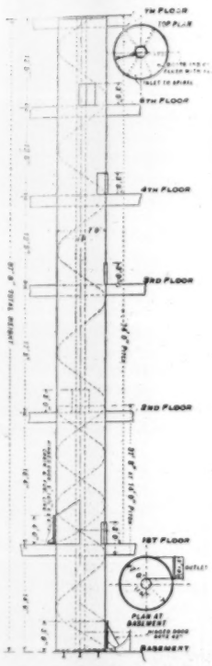

Fig. 7. Spiral Chute for Descending Freight; Newark Warehouse Co.

Freight conveyors are in use at several steamship docks. The Rutland Transit Co.'s pier and the Western Warehouse Co.'s pier (Anchor Line) on the Chicago River have inclined conveyors from the lower to the upper floor. Each consists of a pair of traveling chains with transverse bars fitted with arms which engage with the barrels, boxes or packages. By laying hinged sections of floor at each side of the conveyor, and a line of planks in the middle, the conveyor can be used to carry up ordinary hand freight trucks. The men walk up the planks, and the wheels ride on the side sections of flooring, while the conveyor arms engage with the frame or axle of the truck. Conveyors of the same kind, but with transverse planks fitted to the chains to form traveling platforms, may be used on piers or freight sheds, projecting far enough to serve the deck or side hatch or port of a vessel. Conveyors of this kind are in use at the piers of the Northern Steamship Co. at Buffalo, and those of the Southern Pacific Co. at New Orleans and Galveston.

Elevating conveyors for handling bananas from steamers are also in use at New Orleans, but these are for a special purpose rather than for general freight handling. Traveling platform conveyors of the kind above mentioned are used in unloading cotton bales, etc., from vessels at Donaldsonville on the Texas & Pacific Railway. In the freight house at the dock of the Minneapolis, St. Paul & Sault Ste. Marie Ry., at Gladstone, Mich., is an endless platform conveyor, extending from near the water side of the dock to the track on the railway side. The platform consists of wooden slats fitted to traveling chains. From the inner end of the conveyor runs a pivoted extension which is adjustable to any desired level and which projects over the deck or through the side hatch of a vessel lying at the dock. This is driven from the main conveyor by means of sprocket chains and wheels.

A self-contained conveyor of this kind now being used to load steamers consists of a pair of trusses 35 to 60 ft. long, carrying an endless platform which is fitted with transverse cleats. This is driven by gearing from an electric motor fitted between the trusses, so that the conveyor can be moved about like an ordinary gangway. Flexible conductor cords are connected up at suitable places. It can be fitted with a counter to record the number of packages handled. The conveyor extends from the pier to the deck or side hatch and can be driven in either direction, to load or unload cargo. This is more expeditious than trucking, especially where steep inclines are required to reach the vessel, or where the height is such that the freight has to be handled by steam hoists. By means of a sprocket chain connection, a 50-ft. horizontal extension can be driven from the main conveyor, to distribute or collect freight on the dock or in the freight house. This device may be adapted to railway freight house work. It is used at the steamer docks of the Old Dominion Steamship Co. at Norfolk, Va.;* the Northern Pacific Ry., at Duluth, Minn.; the Great Northern Ry. at Seattle, Wash., and the Tehuantepec National Ry. in Mexico.

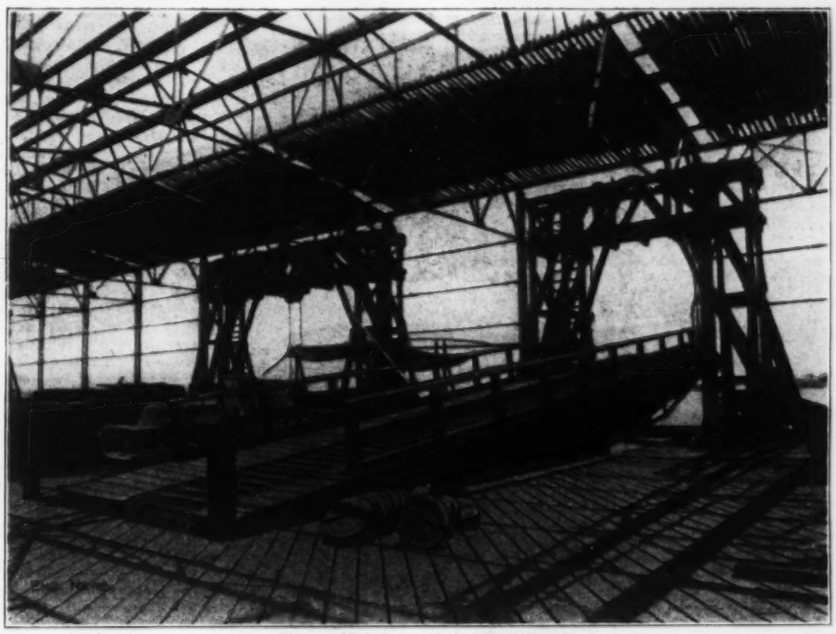

FIG. 8. TRAVELING PLATFORM FOR FREIGHT-HANDLING TRUCKS AT THE SOUTHERN PACIFIC CO.'S DOCKS; NEW ORLEANS, LA.

RAILWAY FREIGHT HOUSE AND WAREHOUSE AT NEWARK, N. J.—This was built by the Newark Warehouse Co., an auxiliary of the Central Ry. of New Jersey, as it had become absolutely necessary to provide in some such way for rapidly unloading inbound cars of merchandise freight, and delivering the material promptly to teams or into the warehouse for storage. The storage feature is incidental to the other, and the number of floors was adopted which it was thought might be expected to keep full in ordinary times. There is no special track layout tributary to the freight house, there being no room for this. It was necessary to take the track into the warehouse out of a crowded yard, although sacrificing convenience in this respect to the necessity of taking care of the warehouse business. The plans were made by John Furguson Co., under general instructions from the office of Mr. Jos. O. Osgood, Chief Engineer. The company was afterwards employed as the general contractor, on a percentage basis. Plans and a section are shown in Figs. 4 and 5.

It is a six-story structure, 360 ft. long, 166 ft. wide at one end and 130 ft. at the other. The height is 102 ft. It is of steel and reinforced-concrete construction, and is fireproof throughout. The walls are of concrete, reinforced sufficiently to prevent cracking and to support the various projections, etc. The floors are concrete slabs reinforced with expanded metal, and have a capacity of 300 lbs. per sq. ft. The track floor, however, is of steel construction, and has a capacity of 500

*Engineering News, Dec. 26, 1907.

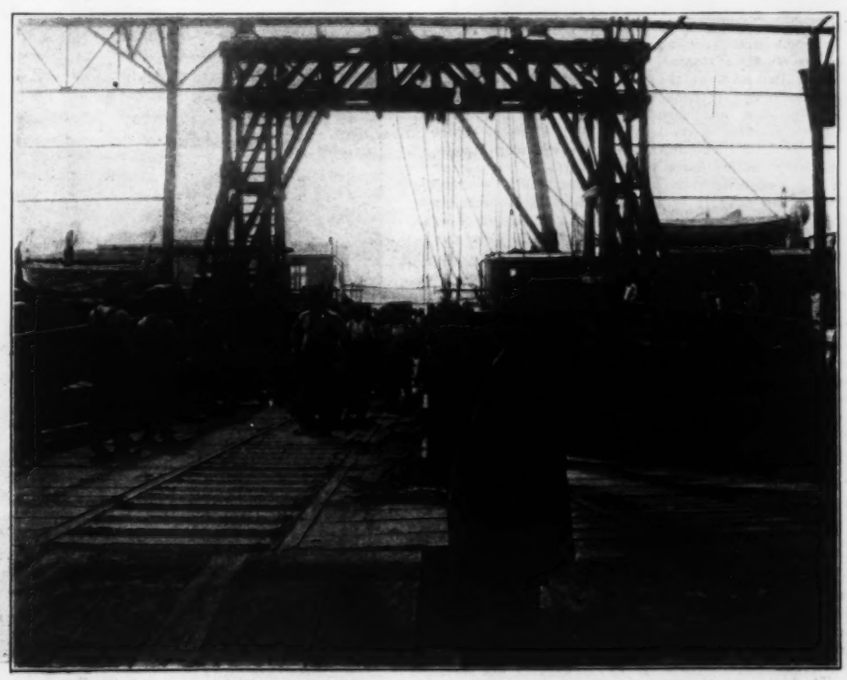

FIG. 9. TRAVELING PLATFORMS FOR UNLOADING A STEAMER.

lbs. per sq. ft. The roof is of concrete slab construction, with a waterproof covering of tar and gravel. The partitions on the storage floors are of hollow tile on steel frames, and have all openings protected by fireproof doors which close automatically. The windows and skylights are of wire-glass in metal frames. There is a complete sprinkler system, supplied by two 30,000-gallon tanks on the roof, which are kept filled by automatic electric pumps. In the basement is a reserve storage tank of 150,000 gals. capacity. The pumps are available for fire service, and there is a connection with a high-pressure main from the city water service. The questions of fireproofing and fire protection were considered of the utmost importance, and as a result of the construction and equipment above described an extremely low rate of insurance is obtained.

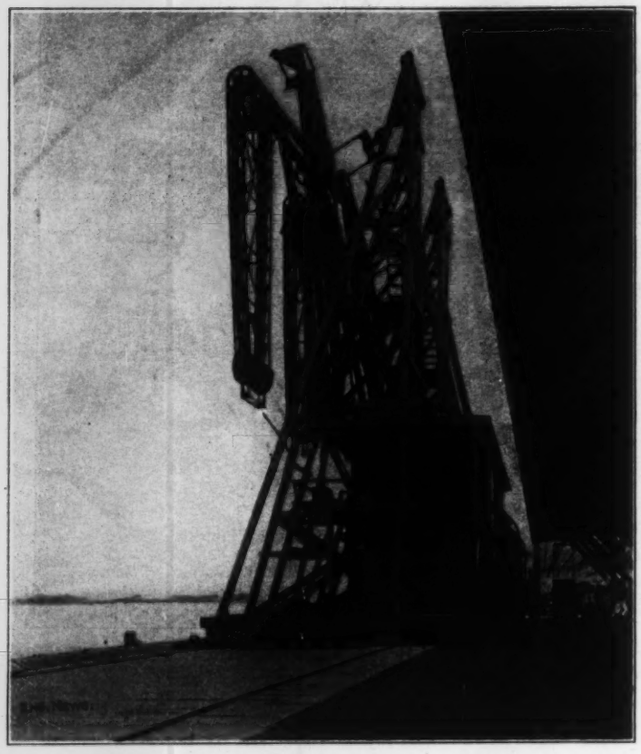

FIG. 10. BELT CONVEYORS FOR UNLOADING BANANAS FROM STEAMERS; NEW ORLEANS, LA.

The floor area is 370,000 sq. ft., and there is storage capacity for about 1,200 carloads of freight. The basement provides storage room and also contains the power plant. The first floor is devoted to the delivery of freight to trucks or teams; the second floor is for tracks, being on the level of the adjoining freight yard; the four upper floors are for storage. The first floor has three large team doors opening to a driveway inside one of the longer sides of the building, with a lateral driveway at each end. The driveways are paved with asphalt blocks on a waterproofed concrete surface, and coated with ½-in. of comparatively soft asphalt as a wearing surface. The floor is so arranged as to drain readily, and it can be flushed with a hose. The driveways serve concrete platforms of about 25,800 sq. ft. in area and with an available frontage of 550 ft. for unloading. The freight delivered from these platforms is received by elevators and chutes from platforms on the track floor or from any of the storage floors.

The second floor has a single diagonal lateral track, with connections to six tracks extending lengthwise of the building. These tracks can accommodate about 40 cars alongside the platforms, which are level with the car floors. These platforms are of irregular shape, owing to the shape of the building and arrangement of tracks. The tracks have curves of 150 ft. radius. On the floor, which is level with the adjoining freight yard, it has been endeavored to provide as much standing room for cars as possible; although in order to do this it has been necessary to install electric winches to handle the cars on some of the tracks. The track rails rest directly upon a steel frame floor, to which they are bolted, with some special precautions to prevent drip through the floor from refrigerator cars, etc.

In order to make a building of this class successful, the facilities for handling the freight must be such as to require a minimum of manual labor. Much attention was therefore given to the number and location of the various appliances. Elevators and conveyors are used, and after considerable investigation it was decided to install gravity or special chutes for handling the bulk of the freight sent from the upper to the lower floors.

PLATFORM ELEVATORS.—There are nine 3-ton Otis electric elevators. Two have platforms 8 × 12 ft., and the others 7 × 10 ft.; six run from the basement to the top floor, two from the first to the second floor, and one from the first to the top floor.

BARREL ELEVATORS.—There are five link-belt barrel elevators, each with a capacity of eight flour barrels per minute. These barrel elevators are of the link-belt endless-chain type, and will carry boxes and bags as well as barrels. Two run from the basement to the top floor and three from the second floor to the top floor. (Fig. 6.)

SPIRAL CHUTES.—There are eight Otis gravity spiral chutes for descending freight. East consists of a sheet steel spiral platform enclosed in a steel cylinder 7 ft. diameter. Three are double chutes, having two distinct spirals within the cylinder, the discharge openings for the two spirals being on different floors. All of the chutes can be used to discharge goods from any floor that they reach. The discharge openings are permanently fixed for each chute; and some discharge at the second floor, some at the first floor, and some in the basement. Barrels, boxes or sacks up to a width and height of 3 ft. can be discharged through the chutes, their capacity being limited only by the rate at which the freight is removed from the discharge end. It makes little difference whether the packages are light or heavy. One chute runs from the basement to the top floor, two from the first floor to the top floor, and the others between the first and second floors and the basement. (Fig. 7.)

A pneumatic tube system communicates with all the platforms and storage floors, and provides quick delivery for bills of lading and orders. Telephones afford ready communication from the platforms to the office on the first floor and also to any of the storage floors, the truck platform and the basement. The building is lighted throughout by electricity.

FREIGHT-HANDLING CONVEYORS O[F] SOUTHERN PACIFIC CO. AT NE[W] LEANS, LA.

Supplementing the information given above report as to the use of freight-[h]machinery, we illustrate in Figs. 8 and 9 of platform conveyor used in unloadin[g] from steamers at the docks of the S[outh]ern Pacific Ry. in New Orleans. As shown Fig. 8, the inner end is pivoted, while the o[ut]end is suspended by cables from a gallows f[rame] so as to be adjusted to the level of the [or] side port of a steamer. Fig. 9 shows t[he] platforms in position to serve two decks. Th[e] trucks (with the truckmen) are carried [by] the traveling part of the platform, wh[ile] the men wheel the empty trucks back on t[he] side part of the floor, as shown. Each travelin[g] platform is operated by a 15-HP. motor, wh[ile] the hoist for raising and lowering is operate[d] by a 5-HP. motor.

At the New Orleans docks there are also ma[chines] for unloading bananas from the fruit st[eam]ers, and these are of special design in view [of] the necessity of avoiding bruises or injury [to] the soft fruit in handling it. Fig. 10 shows t[he] two Harris Edelston Conveying Co.'s unloading machines when not in use, with the conveyor ladders folded up. When a steamer is moored at the dock, the machine is run along the track to the proper position, the horizontal leg of the conveyor swung out, and the vertical leg dropped into the steamer's hatchway. A continuous belt is used, and cross bars form the belt into pockets, in each of which is placed a bunch of fruit. After being elevated from the ship and conveyed across to the dock the fruit is lowered by the belt descending vertically at the back of the tower. As each pocket approaches the level of the floor of the dock the bunch of bananas is automatically dumped upon a padded mattress. Here men pick up the bunches and carry them to the trains. Record is kept of the number of bunches by a man who operates a counter or register with his foot as each man passes him. Another man calls out the quality of the bunches: "A," "B" or "C" ("Ripe," "Nearly Ripe" or "Green"), and the men place them accordingly in one of the three trains waiting for them. Each machine has a 20-HP. 220-volt Westinghouse three-phase motor. For the photographs and particulars we are indebted to Mr. F. G. Jonah, M. Am. Soc. C. E., Terminal Engineer of the New Orleans Terminal Co., New Orleans, La.

FIG. 11. BELT CONVEYOR UNLOADING BANANAS.

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"Empty freight cars don't starve.

"Idle workmen do.

"Socialism will keep both cars and workmen busy."

The first comment to make on the above is that there are not and have not been 400,000 idle freight cars. The maximum car surplusages reported by the American Railway Association were 343,928 cars on Feb. 5, 1908. This surplus had decreased by March 4 to 314,992 cars, and further decrease has taken place since. The total number of freight cars in the United States, however, according to latest statistics, is about 1,900,000, hence the number of idle cars is only about 16%, or one-sixth of the total number of freight cars in service.

Of course, it is not to be denied that to have even this percentage of freight cars out of use represents an abnormal condition; but, on the other hand, the condition of the past few years of chronic car shortage is likewise abnormal.

Nobody—not even a Socialist dictator, if Socialism provided such an official—could possibly so adjust supply to demand that there would always be exactly enough freight cars to meet the needs of shippers and never a surplus to stand idle. The best that can be done is to divide the burden so that the shipper will not have to wait too long for cars and the railways will not have too large an amount of capital invested in idle rolling stock.

Nobody—not even a Socialist dictator—could possibly create uniformity in the currents of traffic. The crops mature in the fall and not throughout the year, regardless of all theories of Government. Passengers on city and suburban railways must be carried back and forth to work in the morning and evening hours, leaving little for men and rolling stock to do in the middle of the day. Not all the surplus of freight cars at the present time is to be ascribed to hard times. Part of it is due to the seasonal variation.

Of course, we must recognize that part of our present condition is due to a wave of business depression. Action and reaction follow each other in the business world as is mechanics. As in mechanics, so in business; the greater the wave height, the greater also is its depth. As we said in this place a few years ago, the way to make prosperity stay is to follow a conservative course in the days when prosperity is at its height. If a thousand manufacturing concerns in the rushing days of 1906 had husbanded their resources instead of building extensions to their plants, they could have done the work now at much less cost. If a few hundred thousand of the workmen who are now out of employment had saved more of their wages, their purchasing power would not now be so greatly reduced and factories would be running to supply these very men which are now idle, thereby reducing the number of these idle workers.

These waves of business activity and depression appear to be too closely interwoven with human nature to permit them to be entirely smoothed out, or affected much by any changes in the form of government. The best that can be hoped for is that with greater intelligence and honesty in the conduct of business affairs, we may learn the lessons of economy and conservatism; be content with a normal growth in times of prosperity and thereby diminish the severity of the recurring cycle of adversity.

It seems high time that inquiry was made into the apparently absolute futility, in many instances, of the rules formulated by the New York State Department of Health for the protection of surface water supplies of municipalities in the State. As many of our readers know, there has been on the New York statute books for many years legislation authorizing the State Department of Health, on application of local authorities, to formulate rules for the sanitary protection of the surface water supplies for which those authorities are responsible. Many an elaborate and stringent set of rules has been drawn up, duly advertised, and in the course of time become, theoretically, at least, legally effective. We presume that there have been instances, and we hope many such, where these rules have been of some service, but in a number of cases that have come to our attention all the labor that was put upon drafting them and all the money spent for drafting and advertising them seems to have been virtually thrown away. The apparent futility of the rules in the case of Watertown, N. Y., was pointed out in Dr. Soper's paper on the Watertown typhoid epidemic of 1904, abstracted in our issue of March 19. Their apparent futility is again made evident by the recent experience of Peekskill, N. Y. At Peekskill there has just been an epidemic of typhoid fever which is attributed to the pollution of the water supply by contract laborers engaged on the new Catskill water supply scheme for New York City. In the monthly Bulletin of the New York State Department of Health for February, 1908, it is stated that, had the local health authorities enforced the rules for the protection of the water supply previously formulated by the State Department of Health, the outbreak would have been averted. There seems to have been even less excuse than usual for non-enforcement of the rules in the Peekskill case, since the authorities were warned by the State Department of Health to enforce the rules in question.

Such gross neglect of sanitary precautions as is indicated by the experience of Watertown, Peekskill and other communities in New York State, although wholly unpardonable, yet has some shadow of an excuse, in view of two difficulties that are involved in enforcing the rules: (1) The whole burden of expense of excluding pollution, including any damages that can be proven, is placed upon the water authority, thus letting the polluter go scot-free; (2) in the Watertown case, at least, and certainly in some others, if not in the case of Peekskill, the necessary sanitary patrol of a surface water supply would extend over such an extent of country as to make its cost prohibitive for any but a large city. Both these conditions emphatically suggest the need of some revision of the law providing for the establishment and enforcement of water-supply protection rules. In many instances the polluters should certainly pay some part, at least, of the cost of protecting public water supplies; and where large drainage areas from which water for many communities is drawn, the sanitary control should be vested in State rather than local authorities.

The habit of appointing special State commissions is not easily given up when once acquired. Accordingly, we find that the New York State Assembly has passed a bill providing for a State Hudson River Purification Commission, whose duties would be "to investigate the pollution of the Hudson River and its tributaries and to make recommendations for preventing the same." The State Health Commissioner is made one of the members of the commission, and we see little or no excuse for not placing all of the work contemplated upon the State Department of Health. This seems particularly desirable, in view of the fact that the Department has already made extensive and very commendable investigations of a considerable number of streams of the State, including the headwaters of the Hudson, and in view of the further fact that the bill carries with it an appropriation of only $6,000, of which practically half is, by the terms of the bill, devoted to the salaries of a secretary and a stenographer. It is true that the Attorney-General is directed to appoint a deputy to render legal services to the commission, and the State Engineer and Surveyor is instructed to deputize an engineer and other assistants to make any needed surveys. But in so far as the services of these officials may prove necessary or desirable there is no reason why they should not as properly be placed at the disposal of the State Department of Health as at the command of a special commission of which the Commissioner of Health is a member. The proposal seems to us directly in line with various others, some of which have been put into effect, in New York and other States, which, instead of strengthening the hands of commissions already in existence and well qualified to carry on contemplated work, really tend to weaken those departments and rarely make for the full attainment of the desired ends.

Republics are proverbially ungrateful, but at least they ought to pay their just debts. A year ago the Southern Pacific Co., in response to a personal appeal sent by President Roosevelt to E. H. Harriman, closed the breach in the Colorado River banks in the face of tremendous odds and saved a vast area of land from destruction by inundation. As was fully shown in Engineering News at the time, the Southern Pacific Co. was the only organization that could possibly have acted in time to avert the impending calamity. It responded promptly and energetically to the call, spared no effort or expense and accomplished the well-nigh impossible. The benefits resultant from this patriotic action can hardly be overestimated. Future generations will tell the story, how an empire of land teeming with a prosperous population would have been an inundated waste of waters but for the heroic work of a great railway corporation in the year 1907.

The Southern Pacific Co. deserves not only reimbursement for its expenditures on this work, but the hearty thanks of Congress by formal resolution. Such things have been done in times or war, and surely an act of great beneficence is as worthy of recognition as an act of destruction.

OBERLIN CARTER AGAIN.

Many daily papers of March 22 and 23 contained dispatches from Chicago asserting that Oberlin M. Carter, who was convicted for the Savannah Harbor frauds, had been "vindicated" by a decision of the U. S. Circuit Court at Chicago. Long interviews were published with Carter and his attorney, stating that he would apply for reinstatement in the Corps of Engineers and repeating the protestations of innocence, which have

been spread before the public ad nauseam for ten years.

It is difficult to be temperate in the use of language in referring to this man Carter; and it is distasteful to have to take space to notice him at all. We should neglect our duty as a representative journal of the engineering profession, however, were we to omit to say that the profession has disowned Carter and will by no means reinstate him. Some portions of the public may be misled into regarding Carter as a martyr by his exploitation in the newspapers; but the engineering profession, to whose honor and reputation Carter dealt as foul a blow as its whole history records, is not deceived.

This very court decision at Chicago well illustrates the methods of Carter and his counsel. Briefly stated, the facts are these:

After Carter's conviction at the Court Martial in 1898, and his final incarceration in Leavenworth penitentiary, the Government attorneys set about tracing the money which he had stolen from the United States through his conspiracy with Greene and Gaynor. Carter had placed much of this money or the securities in which he had invested it in the hands of his father-in-law, R. F. Westcott. When Carter's guilt was established, Westcott refused to hold this property longer and compelled Carter to take it back and give him a receipt for it.*

Carter then transferred these securities, or some part of them, to a brother and uncle. Notwithstanding the fact that Carter had had some three years to hide the money and break the legal chain of evidence connecting these securities with the results of the original conspiracy, the Government officials were able to trace and identify about $450,000 worth of securities. Credit for the skilful work by which this was done is due to Hon. Marion Erwin, of Macon, Ga., Special Assistant U. S. Attorney-General, and Mr. Edward I. Johnson, U. S. Bank Examiner. An order was secured compelling Carter's brother and uncle to deliver these securities to the Court or go to jail. Since then the suit of the Government to establish the identity of these securities with Carter's share of the illicit profits at Savannah has been pending in the U. S. Circuit Court at Chicago.

Since this suit has been in progress a statement appeared in the newspapers and was given wide circulation a few months ago that Carter had been appointed by H. M. Flagler to be Chief Engineer of the work on the extension of the Florida East Coast Ry., to Key West, at a salary of $15,000. Mr. Flagler at once made public denial and declared that the report was absolutely without foundation. The story appears to have been circulated through the newspapers by Carter's representatives simply to give the impression to the Court that there were still people of influence and standing who had faith in Carter's engineering ability and honesty.

Coming now to the pending cases as to the ownership of the securities impounded by the Government: Some weeks ago Judge Kohlsaat of the U. S. Circuit Court decided that as to the bulk of these funds, several hundred thousand dollars, the Government's chain of evidence was complete, and it was entitled to retain possession of that much of the money fraudulently diverted from its treasury by the Carter-Greene-Gaynor conspiracy.

On March 21, in a further decision, Judge Kohlsaat held that as to $45,000 additional, the Government's chain of evidence was incomplete. And this is the decision on the strength of which Carter has had circulated broadcast through the press the statement that his reputation and honor have been vindicated!

We have followed with close attention for ten years the course of the trials of Carter and his co-conspirators. There has never been a case in the courts of the United States where the technicalities of the law were stretched to such lengths to delay and defeat the course of justice. There has never been a case where so persistent an attempt has been made to deceive and mislead the public through the newspaper press and cause it to regard a criminal as a martyr.

Ten years ago when we first investigated the charges against Carter and heard to the full his defense, from his own lips, we found it necessary to accept two alternatives: Either Carter was guilty of the crimes charged against him or else a considerable number of other men of high standing and unblemished reputation were guilty of crimes as black as that with which he was charged and had committed them without any discernible motive.

Nothing better illustrates Carter's well-known habit of smirching everyone else to save himself than his published statement appearing in the New York "Times" of March 23. We quote excerpts as follows:

> I showed that I was entirely ignorant of the connection between my father-in-law [Westcott] and the contractors, Greene & Gaynor. * * * It appears that Greene & Gaynor also had a contract for a sewer in the city of Orange, N. J., where Mr. Westcott lived. He was the most influential citizen in the city and he protected the contractors from interference by the authorities. Then they became connected in a business way. But Westcott never told me anything about it. I was absolutely ignorant of the relation until the charges were made against me.

And so, in the endeavor to save some shreds and patches of his lost character, Carter would blacken the name of his dead father-in-law, Westcott, by insinuating that it was Westcott and not himself who shared the dishonest profits of those Savannah Harbor contracts.

To say that such a man is beneath contempt is to put it mildly. For the criminal who repents, makes frank confession and full restitution so far as possible, and aids to bring to justice his associates in crime, forgiveness and reinstatement may in some degree be possible. But for the hardened offender, who with brazen hypocrisy perpetually proclaims his innocence and strikes like a venomous serpent at all who have aided in placing him behind the bars—such a man deserves nothing but perpetual exile and has no claims to recognition by decent men.

*It may be remembered that Carter originally claimed that he got the money for his high living at Savannah and large investments in New York, as presents from Westcott; but Westcott swore on the witness stand that he gave Carter practically nothing.

THE REMOVAL OF SUSPENDED MATTERS FROM WATER AND SEWAGE.

The bacterial side of water and sewage purification has been so much to the front for many years past that other phases of the subject have frequently been overlooked. But important as is the role of bacteria in both water and sewage purification the success of either process is largely dependent on its efficiency in removing matters in suspension. This is obvious enough where settling basins are being used to remove turbidity from water, but, to go to the other extreme, it is likely to be overlooked in the case of water purification plants designed to guard against typhoid infection. Yet even where bacterial purification of water is the primary object, the task is largely one of dealing with suspended matters, since bacteria really fall in that category, and since, filtration being the chief means employed to remove bacteria, filters operating on the clearest waters eventually become clogged by suspended matters.

If the foregoing reflections be true, the primary function of the majority of water and sewage purification works is the detention of matters in suspension—"first catch your hare." Detention is necessary regardless of how the suspended matters are to be dealt with eventually: whether drawn from a settling basin into water or onto land, scraped from a filter surface or washed from the whole body of the filter bed, or caught in settling basins or on fine-grained filters after having been carried through percolating filters.

The available means of detaining the suspended matters of water and sewage are sedimentation, straining and adhesion. Sedimentation needs no comment at this point. Straining is the strictly mechanical removal of suspended matter by the interposition of barriers which detain the solids but allow the liquids to pass. Adhesion, as here used, is the sticking of suspended matters to a surface or surfaces provided for that purpose. Straining is rarely used, or at least so named, in water purification, but is quite common in sewage purification, particularly in Great Britain and in Germany. Adhesion is still more seldom recognized as a factor in either water or sewage treatment, but nevertheless it is a factor, and a most important one. Straining is almost always accompanied by at least a small amount of adhesion, even when the strainer is a mere screen or sieve. Straining and adhesion together do the major part of the work effected by many water and sewage filters, in which case both processes are frequently lost to sight, owing to the use of the word filtration to describe their joint action.

In filters of any fine material the primary mechanical effect of straining is increased by the fine matter screened out which adheres to the sand. This adhesion takes place both at the surface of the bed and within it, but unless the rate of filtration is rapid or the filtering material is coarse the major part of the heightened screening effect is at the surface, the fine material there retained forming a strainer of even smaller mesh than the filtering material proper. Coincident with the heightened straining effect the efficiency of adhesion doubtless increases as well. Eventually this finer material, whether it penetrates the bed or is merely superimposed upon it, clogs the filter so completely that the filter will no longer pass a sufficient quantity of liquid, and cleaning becomes necessary.

Adhesion having been given so little attention as a phenomenon of water and sewage treatment it may be well to consider it in a little more detail.

In sewage contact beds, which are generally composed of material comparable in range of size with fine to medium gravel, fairly uniform in any given case, the suspended matters are deposited and stick on the surfaces of the filtering material. Contact beds are filled, stand full, and are then drained and finally given a resting period. Consequently, the suspended matters which they retain are well distributed through the whole bed.

Sewage percolating filters, even more than contact beds, must retain suspended matters almost wholly by adhesion, since the material composing percolating filters may be compared in size with uniformly coarse to large gravel, and since the interstices of percolating filters are hundreds of times the size of the particles of suspended matter retained on them. Sewage passes through percolating filters at such high rates that without strong adhesion the filtering material would be washed clean of deposits. As a matter of fact, greater volumes of suspended matter do appear in the effluents of percolating than in those of contact filters; or in other words, contact filters clog more than percolating filters, due to the relative sizes of the filtering materials and the modes and rates of operation of the two classes of filters.

Slow sand filters, both water and sewage, remove suspended matters by both straining and adhesion. The bulk of the material which they remove is retained at or very near their surfaces.

Mechanical filters, which thus far have been used solely for the treatment of water, but may yet be extended to the final treatment of sewage, are essentially strainers of coarse sand, whose efficiency as such is greatly increased by the use of a coagulant to entangle the suspended matters. The resultant precipitate forms a gelatinous layer upon the sand surface, which serves as a highly efficient strainer. Some of the sticky mass is forced by the rapid current of the water down into the filter sand and doubtless acts to some extent as a retainer of suspended matters by adhesion.

In both septic tanks and sedimentation tanks (the former being used to treat sewage only) adhesion plays practically no part and straining absolutely none, the detention of suspended matters being due to sedimentation. Chemicals are often used to hasten the sedimentation of the solids of both water and sewage (coagulation of water; chemical precipitation of sewage).

Our next concern is the disposal of the suspended matters retained by sedimentation, straining and adhesion, or, as more commonly expressed, by sedimentation and filtration. There may first be noted the sharp distinction in the

character of the suspended matters of water and of sewage: the solids in water, being chiefly mineral and non-putrescible, may be generally got rid of unceremoniously at the most convenient dumping place; the solids of sewage, being largely organic and highly putrescible, must be subjected to some process, natural or artificial, that will prevent their being a nuisance after they are discharged from the sewage works. Accordingly the detention of the suspended matters of sewage is but the beginning of the process of sewage treatment. The completion of the process, as now generally conceived, is an attempt to utilize bacteria to change organic matter from a putrescible to a non-putrescible form. This discussion will be chiefly confined, however, to (1) how suspended matters in water and sewage may best be removed therefrom and (2) to what extent can the agent or apparatus of detention be utilized to effect all needed changes in the character of the material detained, so that the material may be disposed of in any convenient way without nuisance.

The ideal method of water or sewage treatment would combine in one operation and receptacle the detention of, and any necessary changes in, suspended matters. Examples of attempts to this end are the sedimentation of water, the septic treatment of sewage and the filtration of either water or sewage. But this ideal of simplicity is in many instances not applicable. Where the nature or volume of the suspended matters or the degree of purification required make a single operation insufficient or uneconomical, as is so often the case, a preliminary and a final treatment must be employed and the work to be done must be so divided between the two as to give the most efficient purification at the lowest possible cost.

The first point to be settled, then, in designing or remodeling water and sewage purification plants, is whether or not a single treatment will be efficient and economical. If not, then careful attention must be given to the division of the work between the preliminary and the main treatment, and perhaps an after treatment as well. To be more specific: where filtration is essential, the question becomes, can the filters do all the work, and if not to what extent and how can their burden best be lightened? The tendency of the day, in both water and sewage purification, and on both sides of the Atlantic, is to lighten the burdens of filters. Sedimentation, coagulation, chemical precipitation, the septic tank, straining or roughing filters are chosen from to relieve or to supplement filtration; or filters are doubled or trebled or further multiplied. Even mechanical water filters, once considered all-sufficient for any water, are now preceded by sedimentation, and the work of slow sand filters is sometimes lightened by coagulation. In designing new sewage works, it would be unusual conditions, indeed, that would now lead any well-informed engineer to place sole dependence on filters of any type.

It can readily be seen that with so many methods to choose from it is easy to make some new combination, or to lay particular stress upon some feature in a combination, or to substitute a new name for an old one, and then come to the front with an announcement of a new process of water or sewage treatment. As an example, attention may be called to the Puech or Puech-Chabal method of water treatment, which is described and interestingly discussed at some length by Mr. Kemna, of Antwerp, in his article entitled "Novelties in Filtration and their Theory," elsewhere in this issue. Mr. Puech is a cloth manufacturer. Like many another user of water in large quantities for industrial purposes he was greatly troubled with suspended matters, and like many before him he set out to get rid of his troubles, evidently with no knowledge of the subject and no attempt to inform himself of what his predecessors had achieved and failed to achieve in the same field. Succeeding by what seemed to him to be a remarkably novel and efficient method, he has since extended his activities into the field of municipal water supply, associating with him a French engineer named Chabal. As to the physical success of his process there appears to be no question, but no information as to its cost, compared with other methods, is available. The process is not new, or if so, then only because of the extent to which pre-filtration has been carried. As an extreme illustration of what he has done, reference may be made to the Suresnes plant, described by Mr. Kemna. There, sand filtration at a rate of 2,500,000 gals. per acre per day is preceded by five pre-filtrations, or strainings. Going backwards from the final filter there are: first, filtration through sand at a rate of 15,000,000 gals. per acre daily, then filtration through gravel of increasing sizes, at daily rates of 45,000,000, 75,000,000, 130,000,000 and 225,000,000 gals. per acre per day. The six filtrations, beginning with the low rate of 2,500,000 gals. an acre, give a net result of less than 2,000,000 gals. per acre per day. As Mr. Kemna interestingly points out, the action of the coarse rapid filters is essentially one of removal of suspended matters by sticking—that is, by adhesion. It is certainly fair to ask whether the same results as Mr. Puech gets by his "degrossiseurs" could not be obtained at less expense and greater convenience by sedimentation, or in extreme cases by coagulation and sedimentation combined.

As Mr. Kemna states, pre-filtration has been used for a number of years at Zurich, Switzerland, as a preliminary to slow sand filtration of the clear water of Lake Zurich. Preliminary or roughing filters have been built in this country at Philadelphia and elsewhere. In England, the native home of the slow sand filter, mechanical filters are used in a number of instances as preliminaries to slow sand filtration. At York, England, sedimentation, mechanical filtration and slow sand filtration have been practiced together for years.*

Without meaning to detract from the interest of Mr. Kemna's discussion nor to rob Messrs. Puech and Chabal of any credit due them, we submit that before adopting the Puech-Chabal preliminary filters it would be desirable to test them alongside Maignen and other American roughing filters, alongside mechanical filters, sedimentation basins and combined coagulation and sedimentation processes, and then to use the results in framing estimates of comparative first costs and total annual costs.

Mr. Puech, in a paper read last September before the Berlin meeting of the International Congress of Hygiene and Demography, laid great stress upon the claim that by preventing the formation of a surface deposit on his filters he made the combined surface area of all the particles of filtering material available for contact, thus affording "the maximum of contact surface to the suspended matters as well as to the microbes." The benefit derived from this contact, he claimed, lies in both the detention of the suspended matter (including bacteria) and its exposure to bacterial action (in so far, of course, as it is subject to such action). The action claimed, it will be seen, is adhesion. Of course, as Mr. Kemna partly suggests, there is more or less contact action in any kind of filter, coarse or fine, and the total contact area increases with the diminution in the size of the filtering material.

What may be termed the Hampton (England) school of sewage treatment makes bold to say that the value of the so-called bacterial filters depends more upon their retention of suspended matters through the presentation of effective contact surfaces than upon bacterial action. The Hampton school asserts, in effect, that sewage filters are essentially detention beds, and that the reduction of suspended organic matters by bacterial action has been greatly exaggerated. Evidence of this, they assert, is afforded by the clogging of sewage filter beds, and is obscured by the practice of crediting to bacterial action all the differences in organic matters shown on analysing crude sewage and filter effluents. We cannot extend this already lengthy discussion by examining this claim, but we think it is worthy of consideration.

Mr. Puech is also exploiting his multiple pre-filters as means for the treatment of sewage, before its application to land. In a paper on sewage treatment which Mr. Puech presented at the Berlin Congress, already mentioned, he showed less familiarity with the history and practice of sewage treatment than he exhibited as regards the treatment of water in his paper on that subject. Passing without further comment than to pronounce it absurd his reference to the Massachusetts sewage experiments at Lawrence (in which he said that filters dosed with crude sewage became clogged "instantaneously," and that therefore sewage filtration was abandoned by the experimenters), we may note how completely he has overlooked the high state of development and wide use of contact and percolating sewage filters, as preliminaries to land treatment, to filtration through sand or as themselves being final processes for use after sedimentation or septic tanks.

Men who exploit patented or proprietary processes of sewage and water treatment inevitably fall into this practice of ignoring all other methods of accomplishing the end which their own process is designed to achieve. It is for this reason that the broader knowledge and the judicial view of the independent engineer should always be secured before a city makes final choice of a water or sewage purification system.

Brief mention must be made of one other point, which is hinted at in Mr. Kemna's discussion of the Puech water filters, and which has but recently been given careful attention in studying the removal of suspended matters from liquids: we refer to those substances which (in making analyses) are at one time reckoned with the dissolved matters of the untreated water or sewage, but which subsequently appear and are counted with the matters in suspension. We refer to the colloids. These, as is indicated by the Hampton studies, and also by Mr. Kemna's comments on the Puech filters, appear to be changed from a condition of pseudo-solution to a state of suspension (or perhaps one should say of precipitation) when liquids containing them are brought into contact with solid surfaces, like particles of filtering material.

Before closing we desire to call renewed attention to the fact that the first problem in dealing with the suspended matters of water or of sewage is one of detention. This may be effected by sedimentation on the one hand, and, on the other by straining and adhesion, which are generally classed together as filtration. Or a combination of sedimentation and filtration may be adopted. Those who give first place to the efficacy of contact, as do Mr. Puech and also the Hampton school, will of course show a preference for filtration rather than sedimentation as a means of removing suspended matters and, we may now add, colloidal matters as well, from sewage and water.

In conclusion, we would say that we have been able to touch only superficially some of the many phases of the removal of suspended matters from sewage and water. The subject is complex and in each of its many ramifications it demands careful study by the chemist, the biologist and the engineer. Our aim has been simply to call attention to this need for the services of the expert in order that there may be determined carefully, in advance of adopting any method of water or sewage treatment, how the work of removing and getting well rid of suspended matters in water and in sewage may best be divided between the several agencies available for that purpose. Any single method is rarely efficient and economical, and only the trained engineer

*An interesting reference to pre-filtration at Reading, England, is made in the London "Surveyor" of Dec. 27, 1907 (p. 659) in a report of a discussion on a paper on "The Water Supply of Paris and Suburbs," by Mr. Easton Devonshire, Assoc. M. Inst. C. E. Mr. L. C. Walker, of Reading, to quote the "Surveyor" said he thought he could claim to come from the place where pre-filters were practically "born." These filters were invented by his father, being first put down in 1891, and patented in 1893, five years prior to M. Puech's patent, so that in that particular direction he did not think they had a great deal to learn from French engineers. They had obtained with those filter chambers or strainers a percentage of purification of 95 before going on to the sand filters, and the average purification for the past five years had been 98.5 and 99.

can be relied on to select the combination best adapted to any specific water or sewage. It should never be forgotten that the removal of bacteria from water and the reduction by bacterial means of the organic matters in sewage, whether in suspension or in solution, are each inseparably connected with the detention of the suspended matters; and that in sewage treatment bacteria can rarely if ever dispose of all the organic matter requiring removal, and that the sludge problem is still with us.

LETTERS TO THE EDITOR.

How Can Piecework be Applied to Fabricating Bridge Material?

Sir: We have been endeavoring for some time past to arrive at some plan by which we might have all shop work on bridges done on the piecework plan. The solution of this problem we find to be very difficult owing to there being so many styles of bridges, the specifications for fabricating them being as various as the styles. We feel that this knowledge would be a valuable asset to us in many ways and are endeavoring to get in touch with some book, party, company or special article which might give us some pointer on the subject.

Very truly yours,
The —— Bridge Co.

[We refer this query to our readers, and shall be pleased to print communications discussing piecework in bridge shops.—Ed.]

An Australian Irrigation-Ditch Water Meter.

Sir: A meter which will give a dial reading, or a paper record, of the flow of water in open channels in gallons or cubic feet has long been desired by irrigators. There are a number of clockwork registers for recording the depth flowing over weirs or through orifices which are effective, but the calculations required to convert these depth records into records of volume involve time and expense and are objected to by the average farmer because he can not interpret them. The ordinary house meter can not be used because, as a rule, the head needed to operate it is more than can be spared. The Venturi meter, while effective, is barred from general use by the cost of the recording gage.

A meter now in use in Australia comes nearer supplying the requirements of irrigation than any the writer has before examined. It is being tested this year by the State Rivers and Water Supply Commission of Victoria, and one has been sent to the Office of Experiment Stations at Washington to be tested by the Irrigation Investigations.

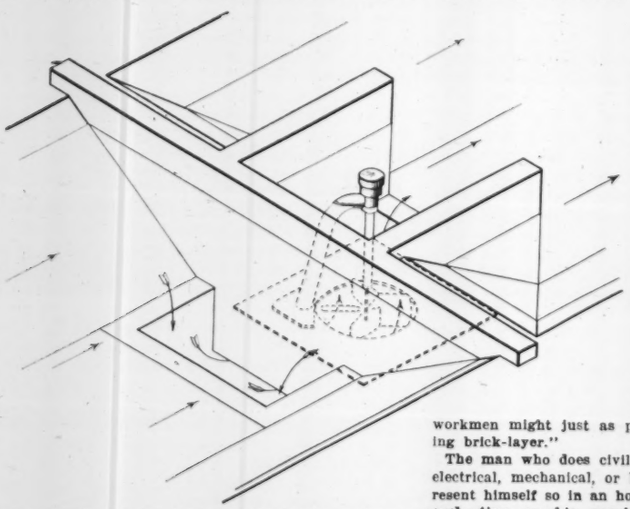


FIG. 1. SKETCH OF AUSTRALIAN METER FOR USE IN IRRIGATION DITCHES.

The general design of the meter is shown by Fig. 1 and four meters in place are shown by Fig. 2. The box shown by Fig. 1 is placed in a pit excavated in the bottom of the ditch channel. The water coming down the ditch is obstructed by a gate and passes down the pit under the bottom of the gate. On the downstream side of the gate is a box with its top level with the ditch bottom; in this top is a circular orifice or aperture. The water which passes under the gate rises up through this aperture and passes on down the channel. In this aperture is a wheel having radial vanes like a windmill or the vanes of a mining aerometer and this is caused to revolve by the upward movement of the water. Its revolutions are indicated on the dial above; this dial can be made to record in gallons, cubic feet, or acre feet. Those to be tested by the Commission this season will register the flow in acre feet.

In tests made by the Victorian Water Supply Department the meter varied from 1.4% to 1.7% from the measured flow. A limit of 5% in the possible error would be near enough for the ordinary requirements of irrigation.

A loss of head of ½-in. will answer for small volumes, but 3 ins. is needed to insure reliable work in the larger ones. Those in Victoria measure flows from ⅓ to 60 cu. ft. per sec.

Respectfully,
Elwood Mead.

The State Rivers and Water Supply Commission, Melbourne, Victoria, Dec. 5, 1907.

[From notation on the back of the photograph sent by Mr. Mead it appears that the device described is known as the Grant-Michell meter, and that one of its promoters is Mr. A. G. M. Michell, Consulting Engineer, 413 Collins St., Melbourne, Victoria. Mr. Mead, we hardly need say, was for many years and until recently Chief of Irrigation Investigations, U. S. Department of Agriculture.—Ed.]

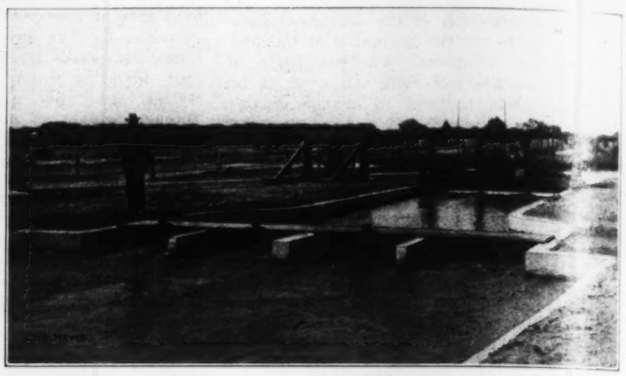


FIG. 2. VIEW OF FOUR IRRIGATION METERS, WITH 39-IN. ORIFICES, IN PLACE.

Use of the Title "Consulting Engineer."

Sir: The writer has for a number of years been an interested observer of the various processes by which "Consulting Engineers" have been evolved. The assumption of this distinguished title has in most cases, no doubt, ample justification from the actual practice of the engineer. Fortunately or unfortunately, however, there is no penalty attached to its adoption by any engineer, young or old, experienced or inexperienced, whose personal dignity may demand greater fore and aft alphabetical embellishment, whether he does consulting work or not, and we do observe a most indiscriminate and unwarranted assumption of the title.

Now it seems to me that a dignified and proper use of the term "Consulting Engineer" would be to apply it to one whose *principal business* consists of reviewing and approving designs, estimates or projects prepared by other engineers of less years experience or attainments in a particular line of work than himself. I believe that this view is upheld by the dictionary, and by eminent practitioners in our own and other professions.

For the ordinary or extraordinary practicing engineer, on salary or fees, who plans, designs, surveys, superintends, contracts, builds, inspects engineering structures —as an architect does his buildings—to call himself a "consulting engineer" is a misuse of language. The good brick-mason who occasionally advises his fellow-workmen might just as properly call himself "consulting brick-layer."

The man who does civil, railroad, sanitary, hydraulic, electrical, mechanical, or bridge engineering should represent himself so in an honest and dignified way *UNTIL such time* as his regular business becomes one of "consultation," or deliberation with others, so that the facts regarding his occupation justify a descriptive title to correspond therewith.

The fact, so aptly commented on by Engineering News in its review of Quebec Bridge testimony, that workmen in field and bridge shops pointed out defects in design which had passed all experts (including their titles), together with the disaster itself, should teach that humility which is proper in one who attempts to direct the forces of nature for the benefit of man.

Is it not a mistaken and un-American notion that so often leads the young designer, who puts out his shingle (possibly because he has lost his salaried job), to adopt a title which does not represent his function at all? Is it not a fact of experience that nothing but a man's name, and what it really stands for in the way of character, ability and achievement, amounts to anything at all in the eyes of the engineering and business public?

Yours truly,

Houghton, Mich., March 6, 1908. J. F. [illegible]son.

[Certainly the indiscriminate use of any title as "Consulting Engineer" is a matter calling for censure. Our correspondent lays down a sound doctrine; and while there cannot well be any restriction other than a man's own conscience and good judgment as to what title he shall write after his name, it is well to have it clearly stated what principles should guide the engineer who desires to observe professional standards.—Ed.]

Concerning Engineering in Brazil.

Sir: The articles of Messrs. F. Lavis and Charles J. Seibert in Engineering News of Nov. 7, 1907, will stand a slight revision, especially that of the latter.

The majority of the men engaged for work in the tropics are not city bred, and if they were that would scarcely be a handicap, since most would have had former experience in rough life in camps in the United States.

Mr. Lavis advocates the stadia for work in these parts. Who ever heard of a stadia survey being the most rapid, and consequently the most economical, in the jungles of tropical South America?

No work was ever started in or out of civilization where it was found that on the day the zero stake was driven too many active men reported for work. More parties begin short handed than with too great a number of men. This is the case everywhere, and it makes things very disagreeable. In the case of the Madeira-Mamore Ry. Co., promotions have indeed been slow, and instead of rodmen acting as transitmen there are transitmen here acting as rodmen. Two instrumentmen have been engaged for this work for each rodman.

Mr. Seibert says he was amused at the joyous and picnic-like air of the Madeira-Mamore Ry. outfit aboard the steamer on the day of departure from New York.

Was it not good policy to take the matter philosophically and keep in a good humor as long as possible? How can one be otherwise than happy when one's labors are nearly 5,000 miles away?

It is a fact, known even to engineers who have spent less than six years in the State of Amazonas, that malaria abounds in the tropics and it is ridiculous for any one to make the assertion that the bantam weights are any more immune from fever than the heavy men.

In looking over your correspondents' opinions of the native laborers, one is struck with such remarks as "'something doing' attracts labor very quickly there and 'nothing doing' disgusts them just as quickly," "every day in the year was a working day except Good Friday," "it was simply work, two meals a day and a few hours' sleep each night," etc. Suffice it to say that time has brought on a change, and from the present outlook history is not likely to repeat itself.

According to Mr. Seibert, Labrea, on the Rio Punis, is not far from Santo Antonio, notwithstanding the fact that to travel one mile in these jungles is to travel 20 miles in an ordinary country, for here every foot of the way is thick cutting. Further on he states that he secured 40 men from the Labrea jail to help unload his cargo, and almost in the same breath he makes the assertion that Labrea is "a place somewhat like Santo Antonio."

Now to secure 40 men from the Santo Antonio jail would mean that about 30 men would be left to run the town. There are on an average about four men in the Santo Antonio jail all the time. Unless the male population of Labrea is a wicked lot, the sizes of the two

towns must be in proportion to the convicts, or as ten is to one.

Yours very truly,

John K. Flick,

Asst. Engr., Madeira-Mamore Ry. Co.,

Santo Antonio, Brazil, S. A., Jan. 15, 1908.

[From a personal letter written by a young engineer on the Madeira & Mamore River Ry. survey, dated at Santo Antonio, Jan. 19, we are permitted to quote the following.—Ed.]

While in Peru I received an unexpected offer to come to this work by way of the Madre de Dios and Beni rivers. I finally decided to come on account of more salary, though the place has a bad reputation. The trip was over [illegible] miles. I came all by canoe with no companions, making such connections as I could. Was hung up 24 days in one rubber camp waiting for transportation; rapids, flies and scarcity of men, as well as an attack of fever, preventing me from either coming that part alone or making other arrangements. The first 120 miles was full of more or less bad rapids, three more in 200 miles and the last 200 was through the famous and dangerous Bajo Beni and Madeira River falls. That part I made with a rubber shipment and took 21 days. The last part was rather exciting, as a good many rapids were shot with full cargo. The whole trip took me nine weeks.

Locating a Leak in Water Mains by Means of Caustic Soda.

Sir: I recently had occasion to locate a leak in a large underground fire service system. The method which I used is, so far as I know, novel and may be of interest to some of your readers.

Several methods depending upon the sound conducting power of the metal hydrants and post valves were tried without success. The cause of this, as found later, was that the leak was not near a hydrant or post valve, but in a pipe joint near a drain, which took the water so that it did not appear on the surface of the ground. The magnitude of the leak was about 6 gals. per min. This fire system was supplied by a 60,000-gal. tank on a 100-ft. trestle, the tank riser joining the yard system at its lowest point.

I placed a pound of caustic soda in a 2-in. pipe connected to the 8-in. tank riser about 12 ft. above its base and so arranged that a very slow current of water could be passed through this pipe into the tank riser, carrying with it the dissolved soda, the plan being that the current of water caused by the leak would carry the alkali to the leak and no further, and also there would be little tendency for the alkali to diffuse into other branches of the fire system, where there were no leaks. All of the pipes were either nearly level or raised slightly from the tank riser, preventing a more rapid diffusion by gravity.

After the caustic had been fed into the riser long enough to have reached the most distant part of the piping system, provided that the leak was located at that point, a flow of water of measured velocity was started at the ends of the several branches of the system and the time was observed when the alkali arrived at the several orifices. From the rate of flow and time, the total volume of acid water was calculated. The pipe sizes being known, the location from which the alkali was brought in the various branches could be easily calculated. A few drops of alcoholic solution of phenolphtalin, in a pail, was used as an indicator to show the arrival of the alkali. The pipe was uncovered at the point indicated by the calculations and the leak was found within 6 ft. of this point. The system consisted of 6, 8 and 10-in. pipe and had a combined length of about one mile. There was, of course, no water taken from the system for other purposes while the test was in progress.

This method would not work as well where the flow of water from the supply to the leak was down hill, as the alkali diffuses very much more rapidly downwards than upwards.

Yours truly,

F. J. Hoxie.

Phenix, R. I., March 10, 1908.

Comparative Costs of Gravity and Reinforced-Concrete Retaining Walls.

Sir: Mr. C. F. Graff, in Engineering News, March 9, 1905, p. 262, gives a series of calculations as to the saving that can be effected by the use of reinforced concrete for retaining walls. He shows a very creditable saving of material running from 36.4% for a wall 20 ft. high to 45% for a wall 40 ft. high.

Herewith are sent several designs of reinforced walls 20 ft. high which, in the opinion of the writer, show a better and more economical form of retaining wall. Comparisons with a gravity wall both as to stability and as to amount of materials required are also given.

Fig. 1 is a section of a heavy gravity wall used on the Kinzie St. track elevation, Chicago. The extended toe and broad base in this design show an evident desire to distribute the load over a large area of foundation. The maximum load or outward pressure assumed for the gravity wall causes the resultant to strike just within the limits of the middle third of the base, the resulting pressures under such loading being the greatest allowable under best practice. This load, 8,100 lbs., is over 33% more than Rankine's formula would give, assuming the material in the fill to take a slope of 33° with the horizontal.

Figs. 2 and 3 are reinforced walls figured for the same loads as that assumed for the gravity wall, with a factor of safety of four for the internal stresses. As to stability Fig. 2 has a larger factor of safety as to tipping forward than the gravity wall as it brings a 14% smaller pressure at the extreme point of the toe. It is therefore less liable to settlement at that point. As to resistance to sliding forward on the base, Fig. 2 is fully equal to the gravity wall. Fig. 3 is designed to bring the resultant at the center of the base. This wall under any load not greater than the maximum assumed has no tendency whatever to tip forward as a whole nor to bring more pressure on the toe than at other points and is therefore an ideal design for compressible foundations, as the settlement, if any, would still leave the wall in a vertical position. It is not as stable as to sliding on the base as Figs. 1 and 2. Its coefficient of friction, however, is 0.44, which is considered safe on most all foundations and with the earth or other material in front of the wall as shown it would be amply safe.

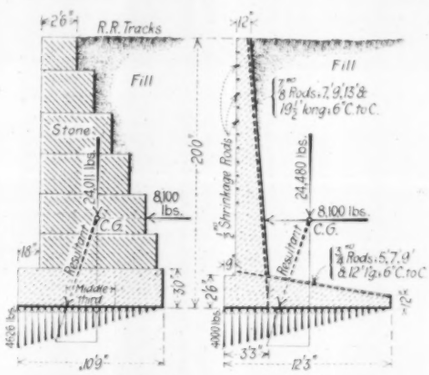


Fig. 1.

Fig. 2.

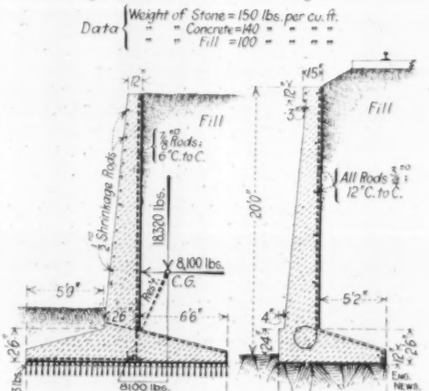


Fig. 3.

Fig. 4.

Comparative Costs of Gravity and Reinforced-Concrete Retaining Walls.

Fig. 4 is a section of wall built on rock foundation. A wall 1,300 ft. long of same section as shown in this design was built in 1906 by the Cincinnati Northern Traction Co. and has proved entirely satisfactory.

As to the saving of materials accomplished by using the reinforced designs the following comparisons are made with the gravity wall. The stone work and the concrete work are estimated $6 per cu. yd., and the steel at 3 cts. per lb. (Straight rods can be placed in the wall for that price with a reasonable profit).

At the above unit prices the saving effected is

in design Fig. 2—49.1%
in design Fig. 3—47%
in design Fig. 4—61.1%

In higher walls the percentage of saving of materials is greater in about the same ratio as shown by Mr. Graff in his calculations for counterfort walls mentioned above.

Yours truly,

Frank A. Bone,

Vice-Pres. and Gen. Manager Concrete-Steel Retaining Wall Co.

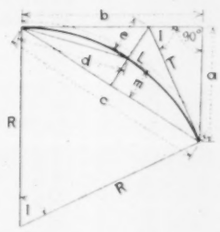
First Nat. Bank Bldg., Cincinnati, O., Feb. 21, 1908.

[The method of computing the reinforced-concrete sections shown in Figs. 2-4, was quite fully explained in Engineering News, April 25, 1907, p. 448, in an article by Mr. Evan P. Bone, on "Reinforced-Concrete Retaining Wall Design." In a long wall or series of walls the difference in cost of laying concrete and erecting forms, due to the thin walls and the presence of the steel reinforcement in the reinforced sections, will make the unit cost of concrete in these latter greater than in the gravity sections. This has not been taken into account in the above analysis. At best, however, it would not amount to more than 10%, so that the reinforced sections are still much more economical.—Ed.]

General Formulas for Simple Curves.

Sir: While employed several years ago upon the Boston Subway (which is nearly all curves), I worked out the following set of formulas which I have not seen published. They are useful in so many ways that I submit them to your readers with a hope that they may serve to bring out "short cuts" from others.

Given any two elements the others are as follows:



$$c = \sqrt{2\,R\,a}$$

$$c = \sqrt{a^2 + b^2}$$

$$c = \sqrt{2\,R\left(R - \sqrt{(R+b)(R-b)}\right)}$$

$$c = 2\sqrt{m\,(2\,R - m)}$$

$$c = 2\,R \sin \tfrac{1}{2}\,I$$

$$c = 2\,T \cos \tfrac{1}{2}\,I$$

$$c = R \operatorname{exsec} \tfrac{1}{2}\,I$$

$$c = R \tan \tfrac{1}{2}\,I \tan \tfrac{1}{4}\,I$$

$$c = T \tan \tfrac{1}{4}\,I$$

$$b = \sqrt{a\,(2\,R - a)}$$

$$b = \sqrt{\left(c + \frac{c^2}{2\,R}\right)\left(c - \frac{c^2}{2\,R}\right)}$$

$$b = R \sin I$$

$$b = a \cot \tfrac{1}{2}\,I$$

$$R = \frac{a^2 + b^2}{2\,a} = \frac{c^2}{2\,a}$$

$$R = \frac{d^2}{2\,m} = \frac{c^2 + 4\,m}{8\,m}$$

$$d = \sqrt{2\,R\,m}$$

$$d = \sqrt{R\,(2\,R - \sqrt{(2\,R+c)(2\,R-c)})}$$

$$d = 2\,R \sin \tfrac{1}{4}\,I$$

$$m = \frac{d^2}{2\,R}$$

$$m = R \mp \sqrt{\left(R + \frac{c}{2}\right)\left(R - \frac{c}{2}\right)}$$

$$m = R \operatorname{vers} \tfrac{1}{2}\,I$$

$$m = R \sin \tfrac{1}{2}\,I \tan \tfrac{1}{4}\,I$$

$$m = \tfrac{1}{2}\,c \tan \tfrac{1}{4}\,I$$

$$a = \frac{c^2}{2\,R}$$

$$a = R - \sqrt{(R+b)(R-b)}$$

$$a = 2\,R\,(\sin \tfrac{1}{4}\,I)^2$$

$$a = R \operatorname{vers} I$$

$$a = R \sin I \tan \tfrac{1}{2}\,I$$

$$a = b \tan \tfrac{1}{2}\,I$$

$$a = T \sin I$$

$$T = R \tan \tfrac{1}{2}\,I$$

$$I = \frac{L}{R} \times 57.295780^\circ$$

$$R = \frac{L}{I} \times 57.295780$$

$$L = I R \times 0.01745329$$

$$L = \frac{8d - c}{3}$$

$$\text{Area Seg.} = \frac{L R}{2} - \frac{R^2 \sin I}{2}$$

$$\text{Area Seg.} = \frac{L R}{2} - \frac{R b}{2}$$

Very truly yours,
J. Calvin Locke.

200 Montague St., Brooklyn, New York City, Feb. 18, 1908.

Sir: Noticing in this week's issue of Engineering News the excellent table of Mr. E. W. Hess for Short-Radius Curves, which, by the way, deserves a place on the fly-leaf of any engineer's pocket manual, I thought it might be of some interest to many having that kind of curves to run to add a method of finding the deflection angle of any short-radius curve with any short chord, which I find very convenient in my own practice.

Suppose that, in running a tramway, we should wish to run in a curve having a 35-ft. radius with a 10-ft. chord, as in the first example of Mr. Hess' table. It is only necessary to take one-half of the chord and divide it by the radius. Thus: 5/35 = .14285, which by referring to a table of natural sines we find to be the sine of 8° 13′ nearly, the required angle of deflection or the half angle of the given chord. (See trigonometrical formulas.) By this method the correctness of Mr. Hess' table can be verified. Then by the formula

$$\tan = R \tan \tfrac{1}{2} I,$$

the tangent distances can be found.

D. C. Weller, C. E.

Waynesboro, Pa., Feb 8, 1908.

HE ANNUAL CONVENTION OF THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

The ninth annual meeting of this association was held March 17, 18 and 19 at the Auditorium Hotel, Chicago, with a registered attendan of 266 members. At the opening meeting on the morning of March 17, the annual presidential address was read by Mr. A. W. Johnston, General Manager of the New York, Chicago & St. Louis Ry. As is customary in this association the address was brief and of a general character, but it referred to the active work and progress of the association and the weight which its work carries with the railway interests.

The large influence of the association is largely due to the fact that it represents both the engineering and operating departments of railway service. Some of its most important work is done by committees working in conjunction with those of other railway and engineering societies; these include the American Society of Civil Engineers, the American Society of Testing Materials, the Railway Master Mechanics Association, the Master Car Builders' Association and the American Railway Association. The association has also taken the initiative in investigating the effects of impact upon bridges, and these tests are now in progress. Allied to this is the work of a special committee (working with the Master Car Builders' Association) to investigate the effects of wheels having flat spots. These two associations are also considering the prevention of brine droppings from refrigerator cars, which not only cause corrosion of rails, spikes and bridges, but also affect the electric circuits of automatic block signals.

The reports of the Secretary and Treasurer showed very satisfactory conditions, which may be summarized as follows: Receipts during 1907, $17,772; expenditures, $13,688; balance for the year, $4,084; total balance, $17,440. The association has now about 700 members.

The convention was a success in every way. There were seven long business sessions; no time was lost in entertainments or excursions, and the only social feature was the annual reception and dinner. There was the usual extensive display of railway material and appliances, the main part of which was arranged on the parlor floor of the hotel. Of the 16 committees, every one had a report, and all of these were printed and distributed in advance. Some of the reports we shall print in abstract, but we give herewith a general review of all the reports and discussions, without regard to the general order in which they were presented.

ROADWAY.

This committee deals largely with the organization and methods of work for carrying out permanent improvements. Last year its report discussed steam shovels and steam shovel work (Engineering News, April 11, 1907). This year it took up the methods to be employed in such work as track elevation (in cities) and grade and curve revision, where the reconstruction has to be done under severe limitations imposed by the necessity of avoiding interference with the regular traffic. In the discussion, Mr. Trimble (Pennsylvania Lines) objected to having a special trainmaster and dispatcher in control of traffic at work of this kind; he considered that it should be handled by the regular officers of the operating department. Mr. Geo. H. Bremner (C. B. & Q. Ry.) replied that on an extensive piece of work it would be much better to operate it as a separate division by itself, with its own operating officers. Mr. J. A. Atwood (Pittsburg & Lake Erie Ry.) objected to specifying just what items of work should be done by railway forces and by contract. At his suggestion this part of the report was modified; it provides that the railway company should handle with its own forces all work which may interfere with operation, while all other work may be let by contract. The mention of sand as the best material for filling on track elevation work was changed to specify simply material which combines low first cost, ease of handling, and stability.

BALLASTING.

This committee presented a brief report, supplementing its report of 1907 in regard to ballast cross-sections. It recommended a side slope of 1 on 2 for ballast of crushed stone and coarse slag; granulated slag should be dressed to the same form as gravel. Mr. D. MacPherson (Canadian Transcontinental Ry.), in a written discussion, thought that stone should stand at 1 on 1½, and that additional material to form a slope of 1 on 2 would be wasted; this additional material would amount to about 200 cu. yds. per mile. The report was adopted, however, with its recommendation of a slope of 1 on 2.

TIES.

This committee worked largely by means of circular letters and sub-committees. Its report is extremely brief, but the reports of sub-committees are given as appendices. In this form, however, the information represents that collected by a few individuals, and not matter that has been discussed and digested by the committee. The first appendix gives the individual replies to a series of questions, for which it appears that failures of ties range from 60% to 100% for decay, 1% to 80% for cutting by rails, and 1% to 40% for cutting by spikes. The two latter classes may be greatly reduced by the use of tie-plates. The life of untreated ties on individual roads is shown to vary as follows: white oak, 5 to 12 years; pine, 5 to 8 (8 to 9 with tie-plates); chestnut, 5 to 15; cedar, 10 to 15; tamarack, 5 to 6; hemlock, 5; cypress, 7 to 9 years. Other appendices give specifications for the analysis of coal-tar creosote, methods for the determination of zinc in treated timbers, and a list of 54 timber treating plants. The most important appendix, of which we give a separate abstract, is that of the sub-committee on the future policy of railways with reference to the tie supply.

Had some of these various subjects been taken up vigorously by the committee itself the results would have been more valuable than in the form in which they now appear. The only recommendations of the whole committee were that the methods given for the analysis of coal-tar creosote and the determination of zinc in treated timbers should be approved as good practice. These conclusions were adopted by vote, and there was no discussion of any part of the report.

RAILS.

The Committee on Rails has conferred with the committees of the American Society of Civil Engineers and the American Railway Association, and in its brief report it points to the desirability of all railways uniting upon a single t[illegible] of section. It is also stated that manufa[illegible]ers of rails claim that they are unable to mak[illegible]est-class rails of the Am. Soc. C. E. section, [illegible] to the thin edge of the base, which claim [illegible]ars to us to be quite untenable as a gener[illegible]o-position. The committee submitted the t[illegible] of sections recently proposed by the Am[illegible]can Railway Association, and stated that the[illegible]ails can be finished at a lower temperature t[illegible] the Am. Soc. C. E. section, but added, "gr[illegible]are must be exercised at the mills to see th[illegible]ails are actually rolled at lower temperatures."

This goes to support the generally [illegible]ted view that improvement in quality depend[illegible] upon methods of manufacture rather than upon [illegible]inor changes in the section of the rail. The [illegible]om-mittee's report also contained a form of [illegible]port for rail breakages.

In connection with this report, Mr. J. [illegible] Snow (Boston & Maine Ry.) presented a paper [illegible]written by Mr. James E. Howard, of the Wat[illegible]town Arsenal, describing tests made there in [illegible]gard to the strength and endurance of steel rails. This paper was presented at the evening [illegible]ession on March 17 and was illustrated by a [illegible]number of stereopticon views of etched sections of blooms and rails representing various stages in the process of rolling. Streaks, lines and hair [illegible]racks were in strong evidence in many cases. In one case, a rail tested to destruction fractured at a point where a slight indentation was made by an accidental hammer blow (possibly in spiking). From this indentation the fracture of the rail began, and its radiant structure could be traced in the section. Other sections represented rails having the surface of the head seriously affected by the skidding of engine wheels, which caused flow of metal and the development of transverse fractures at the corners of the head.

TRACK.

This committee's title is so general that it has never seemed to get its bearings in regard to a line of work, but has touched indefinitely upon various matters. This year it presented a mathematical analysis of a switch layout, together with proposed plans of a standard switch, frog and guard rail. A peculiar feature of the last is that it is only actually parallel with (and 1⅞ ins. from) the main rail for 2 ft., then flaring slightly for 5½ ft. to a spacing of 3 ins., beyond which the end is bent outward in the usual way. The use of glazed sewer pipe with bell ends for the subdrainage of wet cuts was advocated (but with no information as to the reasons therefor). Tables for widening gage on curves to accommodate engines having eight and ten coupled wheels (presumably all flanged), were also given. These had been prepared by a subcommittee, acting with a subcommittee of the American Railway Master Mechanics' Association.

The report stated that it had been voted to recommend to that association that the present ⅛-in. clearance between wheels and driving boxes for new and repaired work be increased to ¼-in. These tables we have condensed in Table No. 1.

TABLE NO. 1. WIDENING GAGE ON CURVES.

No. of Driv. Wheels. Wheelbase	Eight. 18 ft.	Eight. 19 ft.	Ten. 19 ft.
	ins.	ins.	ins.
7°	..	3/16	3/16
8°	2/16	2/16	1/4
9°	3/16	1/4	5/16
10°	1/4	5/16	7/16
11°	5/16	7/16	9/16
12°	3/8	1/2	5/8
13°	1/2	9/16	11/16
14°	9/16	11/16	3/4
15°	5/8	13/16	7/8
16°	11/16	7/8	1
18°	7/8	1 1/16	1 1/16
20°	1	1 3/16	1 3/8

In opening the discussion, Mr. F. S. Stevens (Philadelphia & Reading Ry.) remarked that while the committee had used a proper basis for its treatment of the subject of turnouts, it had included many errors in its table of data relating to turnouts. He also considered the 5-in. throw of switch to be excessive, and other details in the plans submitted as proposed standards for frogs and switches defective. The plans provide for a flangeway 1⅞ ins. wide at frogs and frog guard rails, but it was objected that

this conflicted with the 1¾ ins. provided for by the Master Car Builders' Association, and it was shown that the increase in width of wheel flange by the above association does not necessitate a widening of the flangeway. The report was referred back to the committee for further consideration.

BUILDINGS.

This committee dealt with two subjects: 1. Coaling stations for locomotives; 2. Reinforced concrete roundhouses. The first part was supplementary to the very full report of last year, an abstract of which was given in our issue of March 28, 1907. It called special attention to the economy and desirability of fireproof construction for both coaling stations and roundhouses. In the discussion, various methods of handling coal were mentioned. Mr. R. Montfort (Louisville & Nashville Ry.) said that in some cases where locomotive cranes are used the chutes travel along a coaling track to avoid the long travel of the cranes. The chutes are run to the crane, loaded, and there run into position to discharge into the engine tenders. This method is used at stations handling as much as 500 tons per day.

The report recommended reinforced concrete for roundhouse roofs, but this was modified after discussion. Mr. J. E. Schwitzer (Canadian Pacific Ry.) had had trouble with excessive condensation in roundhouses of this sort; reinforced slabs were then put under the main roof to form a ceiling, but the gases penetrated the slabs and corroded the steel. Mr. C. F. Loweth (Chicago, Milwaukee & St. Paul Ry.) considered that a thin concrete roof would soon be dried out and become porous, so that it would not only have to be protected by waterproofing on the upper side but protected against gases on the under side.

It was pointed out in regard to coaling plants that the adoption of particular types cannot be properly based solely on the amount of coal to be handled.

WOODEN BRIDGES AND TRESTLES.

This committee's work was divided between five sub-committees of three members each. The report itself was very brief, but was accompanied with reports of sub-committees which were submitted, however, only as reports of progress. The first of these gives a form of specification for bridge and trestle timber, prepared in cooperation with a sub-committee of the American Society for Testing Materials. The second and third deal with ballasted-floor trestles and with the preservation of structural timbers. The subject of safe unit stresses for timbers used in wooden bridges and trestles was taken up by another sub-committee, which issued circulars of enquiry and summarized the results. The replies to some of the queries may be presented as follows:

1. Do you distinguish between the unit stress in plain shear and for shear in bending (both parallel to the fiber)? Yes, 6%; No, 94%.
2. Should safe unit stress for timber be modified on account of season checking? Yes, 20%; No, 80%.
3. Ought decay to be considered in fixing any safe unit stress for timber in service? Yes, 38%; No, 62%.
4. As the Association's specifications for steel bridges provide for impact by making an addition to the static live-load stresses, should a similar method be used for wooden truss bridges and trestles? Yes, 13%; No, 87%.

Average values of the returns as to other queries are summarized in Table II.:

TABLE II.—VALUES FOR TIMBER IN BRIDGES.

	Av. values in lbs. per sq. in.				
	W. oak.	Doug. fir.	L-l. yell. pine.	W. pine.	Nor. pine.
Fiber stress in bending..	1,118	1,270	1,330	850	962
Shear parallel with grain.	193	147	150	104	95
Comp. across grain.....	491	293	343	191	190
Comp. parallel with grain.	1,255	1,270	1,323	475	1,007
Comp. in cols. under 15 diams.	967	1,050	1,005	714	766

Appended to this report was a paper on "Open vs. Ballasted Deck Structures," by Mr. A. F. Robinson, Bridge Engineer of the Atchison, Topeka & Santa Fe Ry. The important conclusion of this was that while the open-floor structures may be cheaper in first cost the annual cost per lin. ft. is higher than in the case of ballasted deck structures. In discussing the report of the committee, Mr. Robinson pointed out the greater safety of ballasted floors in case of derailment. The supply of good timber suitable for wooden structures is decreasing and the cost is increasing. As a properly designed solid floor has greater durability than an open floor, the ultimate economy of the former is considerable. Neither in the report nor in the paper mentioned was any reference made to the type of unballasted solid floor construction in which the rails (or the tie-plates) are laid directly upon the floor, which is then covered with a few inches of gravel, etc., as protection against fire.

In the discussion, Prof. W. K. Hatt (Purdue University) remarked that while it may be well to specify (as a precautionary measure) that timber shall be cut from live trees, there are in the western forests large bodies of fire-killed timber that is sound. He also considered that the best class of loblolly pine is a good merchantable timber that is suitable for second-class trestle timbers. Prof. Jacoby (Cornell University) and Mr. H. Von Schrenck (St. Louis) also discussed the proposed specifications for timber. Mr. Hunter McDonald (N., C. & St. L. Ry.) made a motion that dead timber should not be allowed for construction, but this was lost, it being pointed out that while the specifications do not say "live" timber they do say "sound" timber, which covers the objection to dead timber as unsound.

MASONRY.

This committee submitted for final adoption the specifications for stone masonry which have been discussed at previous meetings. These were adopted, without any discussion of the report. The report also suggested the following sizes of stone for concrete, based upon the replies to a circular letter of enquiry:

Considering plain concrete only, and assuming that the aggregate will range in size from ¼-in. to the maximum named, a preference is shown for the following maximum sizes: For foundations, 2½ ins.; for abutments, 2 ins.; for arch rings, 1½ ins.; for coping bridge seats and thin walls, 1-in.

SIGNS, FENCES AND CATTLEGUARDS.

This was the only committee that did not present any information. It reported that it had secured information in regard to snow fences and the removal of snow, but had not been able to put this matter in shape for presentation at the meeting.

SIGNALING AND INTERLOCKING.

The report of this committee was essentially the same as that presented by a special committee at the annual meeting of the Railway Signal Association (Engineering News, Oct. 17, 1907), and dealing with the subject of a method of uniform signaling. It was accompanied by lists of the requisites for different systems of signaling, showing to what extent these depart from the standard code of the American Railway Association.

The committee has followed a systematic course of procedure for the past few years in an endeavor to develop good methods and to secure the approval of such methods by the American Railway Association as an aid to their general adoption. The report also discussed the proposed two-arm block signal system with multiple indications, which was described in our issue of May 9, 1907. In regard to this the committee made the following statement:

The disadvantages of present methods of signaling are felt most on roads having the densest traffic and having schedules calling for the highest speeds. Some roads have adequate signaling for the service required and the defects are in minor details only. On a large percentage of the mileage the signaling has not kept pace with other developments in the attainment of uniformity and completeness, and the committee presents its report in the hope that its recommendations may be carried out for new work and renewals, and that gradual replacement of the various methods by the one here proposed may be made to the end that traffic may be expedited and safeguarded, and that eventually a universal system may prevail which will meet present and future requirements.

The report was adopted without much discussion, and most of this came from engineers, although the committee specially asked for criticisms and comments on the part of those representing the operating departments. The latter probably thought that as the report will now go up to the American Railway Association it will there receive consideration mainly from the operating point of view. At any rate it now has the endorsement of the Railway Signal Association and the American Railway Engineering and Maintenance-of-Way Association.

In regard to distant signals, Mr. Rudd (Pennsylvania R. R.) explained that the report provides for a 45° inclination of the arm to indicate "proceed with caution," instead of using a fish-tail arm in a horizontal position. It is considered that a horizontal arm should not mean "stop" in one case and "proceed with caution" in another case. Mr. Ewing (Philadelphia & Reading Ry.) thought that reference should be made to disk signals, as the report deals only with semaphore signals and appears to discredit the former. Mr. Rhea (Pennsylvania Lines) explained that the matter of disk signals will be taken up later, and that in fact the standard code of the American Railway Association merely mentions disk signals in a footnote.

There was some discussion as to the advisability of a special train-order signal indication which means "stop within specified limits." This should really be classed as a "proceed" and not as a "stop" signal, since it authorizes a train to pass the signal in order to pull into a siding. On motion of Mr. Rhea this indication was eliminated from the list in the report.

Several members pointed out that it is not wise to give too many indications, as the enginemen of fast trains have little time to consider what a particular indication means when the signal comes into view.

RECORDS, REPORTS AND ACCOUNTS.

This committee submitted a report on the requirements and features of right-of-way maps and track maps. It also presented some further discussion as to the methods of handling individual ledger accounts, particularly in regard to a monthly progress report of expenditure, and a record of the completed cost. The first is necessary to guard against possible excess of the cost over the estimate, and therefore shows for each month the amount spent, the total amount spent, and the amount remaining to be spent. The report of completed work serves as a final statement and should be the permanent record of cost. There was considerable discussion, both as to what features should be included on right-of-way maps and track maps, and also as to the blank forms for ledger accounts. The committee's conclusions were adopted with some modifications.

UNIFORM RULES AND ORGANIZATION.

This committee simply submitted a brief set of rules relating to the duties of supervisors of signals. This was adopted after some discussion as to the wording, but the committee fell back on the statement that it was practically the same as in the rules already adopted for supervisors of track and structures, and that uniformity is therefore desirable. On the other hand, if the new rules can be improved, changes should not be prevented by a mere adherence to the form of other rules. Mr. E. F. Wendt (Pittsburg & Lake Erie Ry.) suggested that the rules ought to define the responsibility of the supervisor of signals in regard to the maintenance of insulated rail joints and the maintenance of switch joints as to their limit of throw. As joints and switches come under the care of the supervisor of track, there is an apparent duplication of responsibility which should be guarded against.

WATER SERVICE.

This report was very brief, and stated that "the interest on the part of the association with reference to the work outlined has been so little that enthusiasm on the part of the committee has been rather of a negative quality, because of lack of material." Circulars and letters asking for information brought few replies, and the work of the year was mainly in revising the conclusions previously adopted. There was no discussion.

YARDS AND TERMINALS.

This report constituted a logical continuation of the committee's former reports, and took up some particularly important subjects. We print a full abstract elsewhere in this issue.

A written discussion by Mr. H. M. North (L.

S. & M. S. Ry.) suggested that space can be saved by using a steeper and shorter grade for the approach to a switching hump, and using powerful engines to push heavy trains up this incline. This is the practice in some large yards. He did not approve of a 2% grade over the track scale, nor did he consider a dead-rail necessary on a scale in the hump switching track. He also criticized some of the figures as to number of cars handled in a given time as being exceptional, but in reply to this it was shown that the results under the arrangement proposed in the report would be well within the results that have actually been obtained in practice. He thought the committee might have emphasized more strongly the economic advantages of better design in railway freight houses and warehouses.

Mr. Rhea (Pennsylvania Lines) suggested that the brake testing equipment should be in the receiving yard instead of the departure yard, and cited a case where this practice is followed with success. Mr. F. S. Stevens (Philadelphia & Reading Ry.) called attention to the fact that when the committee first undertook to recommend hump switching there was strong objection made to it on the ground of the resulting injury to cars. Now the case is reversed, and the injury is so slight that cars can be tested before switching, and are then ready for the road. However, he did not think it advisable to let trains leave the yard without testing the brakes.

Mr. Atwood (P. & L. E. Ry.) thought the scales should be 60 or 70 ft. below the summit to allow cars to separate so as not to interfere with each other at the scales. The committee's recommendation of 30 to 40 ft. for this distance was struck out, so that the report provides that it must be sufficient to give proper spacing for the cars.

IRON AND STEEL STRUCTURES.

This report dealt with three main subjects: 1. Inspection, reports and records of railway bridges. The scheme of inspection suggested is as follows: A, Daily, by track men; B, Monthly, by bridge men; C, Quarterly, by bridge men instructed to inspect certain designated structures; D, Annually, by bridge inspectors; E, Annually, by the authorities in charge of bridges in order to decide upon the extent of renewals, reinforcing, etc., during the following year. 2. Classification of bridges by their safe carrying capacity. 3. Impact tests on bridges. This last was a progress report of the sub-committee assigned to the making of impact tests by the use of special instruments which have been described in our columns. The work was carried on for only four weeks, and no attempt was made in the report to draw any conclusions from the results which were presented. The expenses are defrayed from a special fund raised by the association, and this is sufficient to carry on the work for another year.

Another matter which has been taken up by a sub-committee is the limit of length of flat spots on car wheels. The present limit, under the rules of the Master Car Builders' Association, is 2½ ins. Engineers having charge of structures, however, consider that this is too great, especially in view of the effect of such long flat spots under 50-ton cars loaded to their full capacity and moving at high speed. It is suggested that this should be modified in the interests of safety, and that the limit should be reduced to 1¾ ins. Previous efforts have been made to reduce this, but without effect.

The matter was brought to the attention of the Master Car Builders' Association, and a meeting was held by committees of both associations. The matter is under investigation, and the results thus far obtained were presented in a paper by Mr. A. J. Himes (N. Y., C. & St. L. Ry.). He showed that the present limit was adopted in 1878, when the maximum freight car capacity was 40,000 lbs., or a total weight of 62,000 lbs., giving an average of 7,750 lbs. on each wheel. Under present equipment the wheel load may reach 18,750 lbs. Very few statistics are available as to the actual damage to track and cars. While the rails and wheels are stronger than in 1878, the rails are stiffer and the roadbeds firmer, so that the loss in elasticity augments the effect of the blow.

The sub-committee presented a description of apparatus for measuring the effects of flat spots, devised by Prof. C. H. Benjamin, Dean of the School of Engineering at Purdue University, and some particulars of this were given by Prof. Benjamin. He proposes to use an axle having at one end a car wheel with flat spots formed as desired, and at the other end a friction driving wheel. The car wheel would run against the face of a rail bent to a circle of 8 ft. diameter, and the indentations of calibrated metal strips fed between the rail and wheel would indicate the impact effect of the flat spots. The cost would be about $1,500. The sub-committee recommended that the association should undertake an investigation of this kind.

ECONOMICS OF RAILWAY LOCATION.

Last year this committee presented a voluminous report containing a review of train resistance conditions, and the various investigations that have been made, together with some 60 train-resistance formulas. During 1907 it has followed up this subject, and it presented an interesting report of progress. This showed that very few independent experiments have been made as to train resistance, compensation of grades on curves, or the relation of degree of curvature to wear of rails. In view of the great amount of money being expended in grade and curve revision, it would be well worth while to investigate the practicability of reducing frictional resistances, as well as grade resistance.

OFFICERS.

The officers for the present year are as follows: President, Walter G. Berg, Chief Engineer of the Lehigh Valley Ry.; Vice-Presidents, W. McNab, Assistant Engineer of the Grand Trunk Ry., and L. C. Fritch, Assistant to the President of the Illinois Central Ry.; Treasurer, W. S. Dawley, Chief Engineer of the Missouri & North Arkansas Ry. The Secretary is E. H. Fritch, 962 Monadnock Block, Chicago.

TRAIN RESISTANCE AND THE ECONOMICS OF RAILWAY LOCATION.*

By F. W. GREEN.†

The report of the Committee on Economics of Railway Location‡ is the most thorough and comprehensive compilation of data upon this subject now extant.

Any formula for train resistance can hardly be expected to be at best little more than roughly approximate, and its degree of precision depends upon the accuracy of the data from which it is developed. Too often is it the case that observations are made under favorable conditions—track, equipment, weather and power. It naturally follows that a formula, based upon such observations, will yield a larger tonnage rating than an engine can haul except under the most favorable circumstances, whereas the fundamental purpose of developing any formula is to provide a means of calculating a fair and equitable loading for locomotives under average conditions.

The writer has experimentally loaded locomotives with ratings based upon the following formulas: Wellington, Engineering News, Baldwin Locomotive Works, Henderson's first formula, Blood, and Searles. In the majority of instances the results were unsatisfactory, except under very favorable conditions. The following method was then tried, and the results obtained were much better. No dynamometer car being available, the resistance to traction on straight and level track was obtained by taking a series of 10 to 20 observations at critical points, such as ruling grades, stations, sidings, etc., and then making corrections for grade, curvature and acceleration (or momentum). The ratio of the tractive power of the engine to this result would be the tonnage rating on straight and level track. The operation is not as difficult as might seem at first glance, as the following example will show:

An engine with tractive power of 28,400 lbs. starts from a siding with a train of 1,578 gross tons (including weight of engine, tender and caboose) at the foot of a grade rising 45 ft. in 12,600, equals 0.357%. The grade is 12,600 ft. long and the speed of train at summit is 19 miles per hour. There is a curve of 1° 30′ on this grade. Find the equivalent resistance in lbs. per ton on straight and level track.

Let F equal the force of acceleration per [illegible] lbs. per ton.
V equal velocity in miles per hour at su[illegible]
X equal number of 100-ft. stations of gr[illegible]

$$F = \frac{.70V^2}{X}$$

Substituting, we have $F = \frac{.70\,(19)^2}{126} = \frac{252.70}{126}$ [illegible] lbs.

Resistance due to grade = 2 lbs. per 0.1%, or 2 [illegible] 7.14 lbs.
Resistance due to curvature = .56-lb. per degr[illegible] for 1° 30′ = 1.5 × .56 = .84-lb.
Total resistance of train equals tractive pow[illegible]ided by tons = 28,400 ÷ 1,578, or 18 lbs.
Total resistance of train, in lbs. per ton..... 18
Resistance due to acceleration, in lbs. per ton [illegible]
Resistance due to curvature, in lbs. per ton.
Resistance due to grade, in lbs. per ton..... 7.[illegible]

Total known resistances 9.98

Equated resistance on straight and level trac[illegible] 8.02

In actual practice the solution is at times not [illegible]mple as the above, but is never a difficult process at [illegible] time, and anyone with a little experience and prac[illegible] will readily grasp fundamental conceptions. The writer believes this method has some advantage over the usual formulas used.

*From Bulletin No. 97 (March, 1908,) of the American Railway Engineering and Maintenance of Way Association, 962 Monadnock Block, Chicago.
†General Superintendent, Louisiana & Arkansas Ry., Stamps, Ark.
‡Engineering News, May 16, 1907.

TRAIN RESISTANCE.*

This committee has specially under consideration the following:

(1) The value in pounds per ton used respectively by railway engineers in calculating resistance on a level tangent.

(2) Whether the figure is based upon or influenced by any independent experimental work.

(3) Whether any experiments have been made in recent years which confirm or modify the commonly accepted value of 0.04% per degree of curve as the rate of compensation for curvature.

(4) The results of experimental data indicating the effect of curvature of various degrees on the wear of rails.

The answers to the first question were of two classes: (A) the straight adoption of some formula for resistance (such as Wellington's, Baldwin's, etc.), or (B) some value or table of values which were based on more or less definite experiments. The answers of the first class, of course, developed nothing new, but they were interesting, because they indicated the popularity of Wellington's formulas. Baldwin's, Searles', and the Engineering News formulas were also quoted. The flat values varied from 4 to 10 lbs. per ton, and averaged about 6.5 lbs. Some elaborate series of values were quoted, in which the effect of velocity, the dead weight of the car, the proportion of live load to dead load, temperature and other causes for variation, were duly allowed for.

To the second question, a large majority of the answers admitted that no independent work has been done.

Regarding the third question, although independent experimental work was referred to, many of the answers merely stated the practice regarding curve compensation. There was a remarkable amount of unanimity in saying that 0.04% compensation was a little higher than necessary; that 0.03% was too small, and that 0.035% seemed the proper figure. As usual, there were variations, which ranged from 0.02% at one end to 0.08% at the other extreme. The results of some tests made on the Pittsburg & Lake Erie Railroad in 1904 were quoted, in which the effect of ball bearings under the center plates and side plates, in place of flat bearings, were shown to have a very marked influence on the curvature resistance, and hence on the proper rate of compensation. A feature of the answers was the tendency to use a higher rate for the sharper curves.

Regarding the fourth question, the answers were nearly unanimous in saying that no experimental data were available. Some tests on the Baltimore & Ohio Ry. were reported, which were admittedly too few to be conclusive, but which all pointed to the conclusion that the rail wear on curves does not increase as fast as the curvature. Some other results reported in regard to the Norfolk & Western Ry. apparently indicated a rate of wear which varied approximately as the square of the degree of curvature. It was pointed out that the rate of wear is greatly affected by speed, by the tightness of the gage, and also by the use of ball bearings under the center plates and side plates.

Other special features of the work at present being investigated are as follows.

(1) The most economical minimum grade on which trains can be operated, so that it may become a line of greatest possible capacity.

*Abstract of progress report of the Committee on Economics of Railway Location, presented at the annual meeting of the American Railway Engineering and Maintenance-of-Way Association at Chicago, March 19, 1908.

(2) How starting, rolling, flange and other resistances beyond that of gravity can be reduced.

(3) The economical results that may be obtained by increasing the proportion of net to empty tonnage, more especially on the lower grades.

It is clear that the question of reducing the starting and flange resistance is a most important one, for on a very low grade line the starting resistance generally limits the tonnage that can be handled. Any portion therefore of this or other resistances that can be eliminated represents economy in the same sense as that obtained by spending money in reducing grades.

Heavy expenditures have been made by some roads to reduce existing grades to as low as 0.4%; heavy expenditures are being made by other roads to reduce grades below such rate. Take, for example, a road that is reducing its grade to 0.4%. The aggregate resistance on the maximum grade of such a road, using 6½ lbs. as the total resistance outside of gravity (although the committee is not as yet prepared to accept this amount of resistance as correct), is 14½ lbs. per ton. Of this, 6½ lbs. (or about 40%) is due entirely to resistances outside of that of grade.

As millions of dollars have been spent in order to eliminate a few pounds of resistance per ton by reducing grades, is it not practicable, and may it not be truly economical, to reduce the resistance by eliminating some portions of flange, rolling and other frictional resistances? Is it not also expedient to make experiments to investigate the possibility of reducing this class of resistance, as well as by trying to reduce a few pounds per ton in grade resistance by the expenditure of immense sums of money?

HENRY FARMAN, THE AERONAUT who made a successful flight with a "heavier-than-air" flying machine at Paris, winning the Deutsch-Archdeacon prize, as noted in Engineering News, Jan. 16, is reported as having described a circular course of 1½ miles in 2 min. and 15 sec., on March 20.

THE QUESTION OF SMELTER SMOKE is to be investigated by a committee appointed by the Mayor of San Francisco, according to the "Engineering and Mining Journal" of March 21. A report is to be presented to the San Francisco Board of Supervisors in order to prevent the board from passing an ordinance detrimental to the erection of the San Bruno smelter of the American Smelting and Refining Co. Mr. Charles G. Yale of San Francisco is in charge of the preparation of the report.

IN AN EXPLOSION in a press mill of the United States Powder Co., at Coalmont, Ind., on March 17, three men were killed and several others were seriously injured. Every window in Coalmont was broken, it is reported, several buildings were damaged and the explosion was felt 30 miles away. The cause is unknown. In an explosion of gas in the Iron Mountain Tunnel Mine near Helena, Mont., four men were fatally burned. By an explosion of gas in the Eagle Hotel at McKee's Rocks, Pa., a suburb of Pittsburg, six men were seriously burned and the building was partly wrecked.

THE PREPAYMENT TYPE OF STREET CARS for the Madison Ave. line, New York City, which was described in Engineering News, Nov. 21, 1907, were placed in service Sunday, March 22, after several months' delay in completing all preparations for the service. It is reported that the results of the few days operation have been all that was expected. The public took kindly to the cars and in few cases were any delays due to making change. The boarding and leaving passengers were handled smoothly at congested junctions of cross-town lines although it is claimed by many observers that, owing to the mixed collection of cash fares and transfers, a heavy percentage was not recorded on the fare register which the conductor worked with his foot. It is proposed to install nickel-in-the-slot recorders to overcome this trouble. It was found that unless the cars were run slowly on curves they were apt to get stuck owing to their size, causing a blockade. However, the motormen, after a few such experiences, learned to take the curves properly. When the cars contained 75 passengers a sign "Full Car" was displayed and stops were made only to discharge passengers.

RAILWAY ACCIDENTS during the past week have been numerous and fatal. On March 20 in a head-on collision of two freight trains on the White Mountain Division of the Boston & Maine R. R. the engineers and firemen on both engines and one brakeman were killed. The accident occurred on a sharp curve with an upgrade near Haverhill, N. H., and was caused, it is reported, by a mistake in train orders. The Boston & Maine here is a single track line with many curves and bridges. The "Diamond Special" over the Illinois Central R. R. from Chicago to St. Louis was derailed on March 21 near Springfield, Ill., and plunged over a 40-ft. embankment. It was found that the spikes had been removed from a portion of the track. No one was killed and none seriously injured. On the same day a Missouri Pacific passenger train collided with a freight near Independence, Mo., injuring eight persons. A locomotive of the Delaware & Hudson Co. blew up at Schenevus near Oneonta, N. Y., early in the morning of March 22 while taking water, killing the engineer, fireman and head brakeman. The locomotive was one of the oldest in the company's service and it is believed that the boiler was defective. A storage building about 20 ft. from the locomotive caught fire from the scattered cinders and was entirely destroyed. Forty persons were injured in Detroit, March 24, when an interurban electric railway car plunged into a storefront. The car and storefront were completely demolished.

A STATE HUDSON RIVER PURIFICATION COMmission is provided for by an act which passed the New York Assembly on March 13, but which still has to pass the Senate and be approved by Governor Hughes before becoming a law. Under the terms of the act, the Governor is authorized to appoint two citizens who, with the State Commissioner of Health, shall constitute the commission named. The commissioners would receive no compensation, but their expenses would be paid by the State. The commission would be authorized to appoint a secretary at a salary not to exceed $2,000 a year, and also to appoint a stenographer. The Attorney-General of the State would appoint one of his deputies to render legal services, and the State Engineer and Surveyor would "designate an engineer and such other assistants as may be required to make such surveys as may be found desirable." The commission would proceed at once to make such investigations as may be proper to determine the causes of the pollution of the Hudson River and its tributaries, and to determine what, if anything, can be done to prevent such pollution.

The act directs that the commission shall report to the Legislature March 1, 1909, with recommendations. The sum of $6,000 is appropriated for the work of the commission.

THE NEW YORK METROPOLITAN SEWERAGE Commission has been reorganized with some new members and with Dr. Geo. A. Soper, M. Am. Soc. C. E., as President, and Mr. James Fuertes, M. Am. Soc. C. E., as Secretary. The other members of the commission are Mr. Charles Sooysmith, M. Am. Soc. C. E.; H. deB. Parsons, M. Am. Soc. C. E., and Dr. Linsly R. Williams. The commission, in a report to Mayor McClellan, states that $75,000 is needed to complete its investigations of the pollution of the waters adjacent to New York City.

BIDS FOR REDUCTION WORKS at Columbus, O., will be received on May 11, 1908, in accordance with new specifications. The new specifications do not differ materially from the old ones, on which bids were invited for Jan. 14, 1908 (see Eng. News, Jan. 2, 1908), except that certain levee construction called for in the earlier specifications is omitted, and the allowable percentage of moisture in the dry tankage has been increased from 3 to 6 and the amount of grease in the dry tankage from 1 to 2%. The works in question are to be built by the city, under the direction of the Board of Public Service.

FILLING OLD STEEL VIADUCTS with solid embankments has been practised in several cases on the Cincinnati Southern Ry., many of these being rock fills with concrete culverts. The filling is done by dumping the material from trains standing on the structures, and no steps were taken to recover the old iron work, except the stringers. It was considered impracticable to do this at any cost that would be warranted by the results, the old viaducts being of light construction and the material (as scrap) would not be worth the cost of saving.

PERSONALS.

Mr. Henry R. Towne, M. Am. Soc. M. E., President of The Yale & Towne Mfg. Co., has been elected President of The Merchants' Association of New York.

Prof. A. W. French, M. Am. Soc. C. E., Worcester Polytechnic Institute, has been appointed a member of the Worcester public improvement commission.

Mr. John C. Spiers, formerly factory manager of the Autocar Co., Ardmore, Pa., has been appointed factory manager of the Standard Roller Bearing Co., Philadelphia, Pa.

Mr. Oscar Erlander, M. Am. Soc. C. E., who has been captain of the 1st Company, Signal Corps, National Guard of New York, has been promoted to the grade of Major in the Signal Corps.

Mr. Rensselaer H. Toll, M. Am. Inst. M. E., formerly superintendent of the Mancos Consolidated Gold Mining Co., has opened an office as consulting engineer at 522 Mining Exchange, Denver, Colo.

Mr. J. C. L. Fish, Assoc. M. Am. Soc. C. E., Division Engineer of Construction, Lake Shore & Michigan Southern Ry., will become Professor of Railway Engineering at the Leland Stanford, Jr., University.

Mr. Albert Enderlen, Bridge Engineer of the Gustavsburg Bridge Works at Gustavsburg (near Mainz), Germany, is visiting this country for the purpose of examining American bridges, bridge works and bridge design.

Mr. Frank F. Fowle, formerly manager of the operating department of the American Telephone and Telegraph Co. at Chicago, Ill., has opened an office, as consulting electrical and telephone engineer, in the Marquette Bldg., Chicago.

Mr. John C. Sesser, Assoc. M. Am. Soc. C. E., Engineer of Maintenance-of-Way on the Chicago, Burlington & Quincy Ry., has resigned to take the position of Vice-President of the W. K. Kenly Co., of Chicago, dealers in railway supplies and equipment.

Mr. D. F. Fulton, who has been in charge of preliminary surveys and borings in Residency No. 1, Champlain Div., New York State Barge Canal, having practically completed the work, has resigned to accept the civil service appointment of Assistant City Engineer of Yonkers, N. Y.

Mr. Addison N. Clark, formerly assistant editor on the Engineering News staff, has been appointed Superintendent and Engineer of the properties of the Arizona-Nevada Gold Mining and Milling Co., near Luning, Esmeralda County, Nevada. The post-office address of the company is Luning.

Mr. Enos A. Wall, M. Am. Inst. M. E., Vice-President of the Utah Copper Co., of Salt Lake City, has established a research fellowship in the Utah State School of Mines which is the engineering department of the University of Utah. This fellowship has an annual value of $500 and is to be awarded to graduate students of ability to promote research in mining, ore dressing and metallurgy.

Capt. Frederick W. Alstaetter, Assoc. M. Am. Soc. C. E., Corps of Engineers, U. S. A., has been transferred from the river and harbor work at Pittsburg, Pa., to relieve Capt. F. C. Boggs on the improvement of the Kanawha and Little Kanawha Rivers at Wheeling, W. Va. Capt Boggs has been ordered to Washington, D. C., for duty under the orders of Col. H. F. Hodges, M. Am. Soc. C. E., Corps of Engineers, U. S. A., purchasing officer of the Isthmian Canal Commission.

Mr. S. W. Eccles, formerly traffic manager of the American Smelting and Refining Co., has been elected a Vice-President of that company and of the Smelters Securities Co., and will have general charge of the mines and plants of both companies. In connection with this work he has been elected a Vice-President in the Nevada Consolidated Copper Co. and in the Cumberland-Ely Copper Co. Mr. S. W. Sproule has succeeded Mr. S. W. Eccles as traffic manager of the American Smelting and Refining Co.

The "Age" of Melbourne, Australia, in its issue of Feb. 7, prints the following item:

It is the intention of the Government to appoint Mr. Elwood Mead, Chairman of The Water Commission, to the additional position of Acting Engineer of Water Supply, on the retirement of Mr. Stuart Murray at the end of the present month. The Minister of Water Supply stated yesterday that Mr. Mead would occupy the position for a time to enable him to judge whether he could take it permanently in addition to his other duties. Mr. Mead thoroughly understood that the Government did not wish to impose upon him any duty that would prevent him from giving the fullest necessary attention to the development of irrigation, but, as much of the work of the Water Supply Department would consist in the construction of irrigation works, the two departments should, if possible, be associated under one head.

Mr. E. W. Moir, M. Am. Soc. C. E., Vice-President of S. Pearson, Inc., was presented on March 20 by the engineers and workmen employed on the Pennsylvania R. R. East River tunnels with a model of a medical air lock. Mr. Moir built the first medical air lock ever constructed and this presentatiou was an appreciation of the work done to relieve compressed-air workers of some of the fatal results of their work. The model is made of brass, oxidized to look like steel, is mounted on mahogany and has a silver name plate. It is built to a scale of 1½ ins. to the foot, and measures 2 ft. 6 ins. long × 9 ins. in diameter. It is complete in every respect, being lighted with electric lamps and compressed air being supplied by an air pump. The hospital beds for the men to lie on, and the compressing and decompressing valves, along with thermometers and pressure gages, are shown in full detail.

Obituary.

Matthew McClung, Jr., superintendent of the Joliet blast furnaces of the Illinois Steel Co., died of blood poisoning on March 3 at the age of 36 years. He was born in Knoxville, Tenn., and graduated from Lehigh University with the class of 1904.

Charles H. Campbell, Past President of the American Water-Works Association, shot himself in New York

City on March 24. He came to New York in 1907 from Atlanta, Georgia, and became advertising manager for F. W. Shepperd, publisher of "Fire and Water Engineering."

John W. Kelley of Brownsville, Texas, died on Feb. 10 in La Paz, Bolivia. For two years he had been purchasing agent of the Bolivia Railway Co. He had been a student at the Texas and Pennsylvania State Colleges and before going to Bolivia had been connected with railway work in the United States, Mexico and Cuba.

Stanislaus P. Franchot of Niagara Falls, N. Y., died in Montreal, March 24, after an operation for paralysis. He was born in Morris, Otsego County, New York, Jan. 30, 1851, and graduated from Union College in 1871. He had engaged in mining work in Buckingham, Quebec and in oil operations near Titusville, Pa. In 1897 he came to Niagara Falls and established the National Electrolytic Co., one of the successful electrochemical industries of that place. In 1906 he was elected to the New York State Senate.

Leopold Eidlitz, a retired architect, died at his home, 309 West 89th St., New York City, on March 22, at the age of 84. He was born in Prague, Bohemia, and after studying architecture in Vienna and at the Prague Polytechnic School came to this country. In 1875 he was Special Supervising Commissioner on the remodeling of the State Capitol at Albany. He designed Christ Church, St. Louis, St. George's Church, the Brooklyn Academy of Music, Dry Dock Bank and the Continental Bank, in New York City. He was a member of the American Institute of Architects and an honorary member of the British Institute of Architects.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN RAILWAY ASSOCIATION.
April 22, 1908. Semi-annual session at New York City. Secy., W. F. Allen, 24 Park Place, New York.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 1-2, 1908. Annual meeting at Albany, N. Y. Secy., Joseph W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN WATER-WORKS ASSOCIATION.
May 11-16, 1908. Annual meeting at Washington, D. C. Secy., John M. Diven, 14 George St., Charleston, S. C.

NATIONAL ELECTRICAL LIGHT ASSOCIATION.
May 19-22. Annual convention at Chicago. Secy., W. W. Freeman, 29 West 39th St., New York City.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 26-28. Annual meeting at Chicago. Secy., W. H. Merrill, Jr., 382 Ohio St., Chicago.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 9-11. Annual convention at Toronto, Ont. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago,

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 22-24. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago,

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 23-26, 1908. Annual convention at Denver, Colo. Secy., C. W. Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 23-26, 1908. Annual convention at Detroit, Mich. Secy., C. W. Rice, 29 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 23-27. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 29-July 2. Annual convention at Atlantic City, N. J. Secy., Ralph W. Pope, 33 West 39th St., N. Y.

RAILWAY SIGNAL ASSOCIATION.—At the meeting held at the Great Northern Hotel, Chicago, on March 16, the morning session was devoted to a discussion of the report of the committee on Standard Specifications for Electric Interlocking. This report was presented at the annual meeting held in Milwaukee in October, 1907. After considering the discussions the committee will revise its report for presentation at the next annual meeting at Washington, D. C. At the afternoon session there was continued discussion of a paper on "The Economical Operation of Electric Signals, and the Care and Maintenance of Storage Batteries in Signal Work. This paper was by Mr. C. R. Cook, and was read at the meeting in New York in January. The only other subject for discussion was the report of the committee on Specifications for Automatic Semaphore Block Signals Operated by Direct Current for Steam Railways.

ASSOCIATED FOUNDRY FOREMEN OF CHICAGO.—The second annual meeting was held at the Lewis Institute, Chicago, March 5 to 7. Addresses were made by Director Carman, of the Institute, Mr. R. Moldenke, Secretary of the American Foundrymen's Association, and Mr. E. A. Johnson, Director of Foundry Work at the Winona Technical School, Indianapolis. The foundry instruction work at the institute was inspected, and there was a special meeting of technical school instructors in foundry and pattern shop work. Mr. C. C. Kawin read a paper on "The Work of the Commercial Chemist," and Mr. E. H. Mumford gave a moving picture illustration of the French system of universal molding. There was a large exhibit of foundry machinery, appliances and supplies from nearly 30 exhibitors. The officers elected were as follows: President, Eugene W. Smith, Foundry Superintendent of the Crane Co.; Vice-President, W. J. Legg, foundry superintendent of the Featherstone Co.; Secretary, C. E. Hoyt, instructor in the foundry department of the Lewis Institute, Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The Board of Directors has made the following nominations for the next annual election, the ballots for which are to be counted May 1. For President, Mr. L. A. Ferguson, Vice-Pres. Chicago Edison Co., Chicago, Ill.; for Vice-Presidents, Mr. C. C. Chesney, Chief Engineer of the Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.; Mr. Calvert Townley, Vice-Pres. Consolidated Ry. Co., New Haven, Conn.; Mr. Bancroft Gherardi, American Telephone and Telegraph Co., New York City; for Managers, Mr. D. B. Rushmore, General Electric Co., Schenectady, N. Y.; Prof. H. E. Clifford, Massachusetts Institute of Technology, Boston, Mass.; Mr. C. A. Stone of Stone & Webster, Boston, Mass.; Mr. W. G. Carlton, New York Central R. R., New York City; for Treasurer, Mr. G. A. Hamilton, New York City; for Secretary, Mr. R. W. Pope, New York City.

At the monthly meeting held at the Engineering Societies Bldg. on March 13, Messrs. L. B. Stillwell and H. C. Putnam presented a paper on "Electric Haulage of Canal Boats." The paper was a set of notes based on the results of tests conducted in the autumn of 1907 on a section of the Lehigh Canal near Mauch Chunk, Pa. These tests were undertaken to determine, (1) pull required for various numbers of boats and for various speeds; (2) the relative merits of locomotives on a 42-in. gage track and a monorail system; (3) the best speed and length of tow; (4) power required to operate between Coalport and Bristol; (5) the equipment for such operation. These notes presented the conclusions arrived at for the first three of these problems. The tests showed that a good team of mules could exert momentarily a pull of 800 lbs. The pull required at 2 mi. per hr. was 250 lbs. per boat. At 1.75 mi. per hr. it was 190 lbs. and at 1.5 mi. per hr. it was 140 lbs. Little difference was shown in the efficiency of the two systems tried. The authors of the paper concluded that single boats could be operated on tangents at speeds above 5 mi. per hr., but that ordinarily 5 mi. per hr. would be the limit of speed for satisfactory operation. Two-boat tows are handled satisfactorily at 3 to 4 mi. per hr. Four-boat tows, loaded, were operated fairly well up to 3 mi. per hr., but when light were too troublesome especially in heavy winds.

In the discussion Mr. H. St. J. Clark, Chief Engineer New York & Long Island Traction Co., held that as towpaths were considered public highways any mechanical traction scheme used must leave the path unobstructed. Dr. C. P. Steinmetz asked if data had been collected to show whether or not electric canal haulage could compete with mules on the fluctuating or light traffic of most canals on account of the investment costs of the former and its periods of idleness.

WASHINGTON SOCIETY OF ENGINEERS.—At the meeting held on March 17, an address illustrated by lantern slides was delivered by Mr. Calvin W. Hendrick, M. Am. Soc. C. E., Chief Engineer of the Sewerage Commission of Baltimore, Md.

Before taking up the great sewerage and sewage disposal scheme now being carried out at Baltimore under Mr. Hendrick's direction, the speaker made some general remarks on engineers and engineering. He spoke of the backwardness of sanitary engineering until a comparatively recent date. On the subject of sewage treatment he quoted from a recent address before the Royal Sanitary Institute, by Sir William Ramsay, a member of the (British) Royal Commission on Sewage Disposal, as follows:

> There can be no finality in investigations of the nature of those relating to sewage disposal. New researches are constantly extending the domain of science, and in view of the very little that is definitely known concerning the nature of the processes taking place in the purification of sewage and water, it is certain that the future will reveal many important facts now hidden. For this reason the Commission believes that a permanent laboratory staff should be formed, so that continuous work on the chemical and biological aspects of the sewage problem may be conducted.

Mr. Hendrick expressed the opinion that before long it would be necessary for the U. S. Government to take up sewage disposal and to frame and enforce laws governing both methods and conditions of disposal as related to interstate streams.

Coming to the Baltimore work, Mr. Hendrick stated that Baltimore now has a population of 600,000, and that the plans carried out are designed for a population of 1,000,000 and involve a disposal plant with an ultimate daily capacity of 270,000,000 gals. gathered by some 850 miles of sewers and house connections. Storm water will not be treated, but the present storm-water sewers will be extended, particularly after sanitary sewers have been provided.

Within nine months from the time engineers were placed in the field, the Baltimore Sewerage Commission had made surveys and completed plans and specifications for extensive sewerage construction work and let a number of contracts for both sanitary and storm sewers. The estimated cost of the work got under way thus early was $788,000. Since then, contracts for sanitary sewers estimated to cost $2,136,000, and storm sewers to cost $528,000, have been let. In addition, contracts which will probably amount to $530,000 are now ready to let.

A proposed high-level intercepting sewer, running from the eastern to the western limits of the city at about Elev. 60 and ranging in size from 8 to 100 in. will carry two-thirds of the sewage of the city through the Back River disposal works by gravity. The sewage from the remaining third of the city will be collected in east-and-west low-level intercepters terminating at a pumping station. In this station it is expected that there will eventually be five 27,500,000-gal. pumps, and of these three will be installed at the outset. A force main leading from this station to the high-level intercepter will operate under a dynamic head of 72 ft. From the junction of the force main and the high-level intercepter, an outfall sewer 12 × 11¼ ft. in cross-section and 5¾ miles long will lead to the disposal works. It will be built of concrete, with a semi-vitrified brick lining up to the springing line. At special points, as where passing beneath railroads, the concrete will be reinforced.

The 850 miles of sanitary sewers and house connections will cost approximately $14,000,000, and the projected 183 miles of storm sewers will cost about $4,500,000. The Commission expects to complete its work about 1914.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting of the society on March 18, Mr. William J. Wilgus presented his paper upon "The Electrification of the Suburban Zone of the New York Central & Hudson River R. R. in the vicinity of New York City." A special invitation to attend the meeting had been extended to the members of the American Institute of Electrical Engineers and many of this society availed themselves of the opportunity to listen to and discuss this first authoritative statement of any official of a railway as to the reasons for adopting and the economic results from the particular kind of equipment which has been installed. The paper of the evening was entirely too long and complicated to be read in toto but Mr. Wilgus gave a resume of the work together with lantern views of the various constructions. This was supplemented by a short illustrated talk by Mr. E. B. Katté, M. Am. Inst. E. E., Electrical Engineer of the New York Central, on the electrical equipment, more particularly in the power houses and substations. Mr. George R. Henderson, M. Am. Soc. M. E., called attention to the fact that although the figures in Mr. Wilgus' paper showed lower costs of operation for an electrically operated road, such figures must be taken as applicable purely to that kind and amount of traffic and operation for which they were recorded. Inasmuch as the fixed charges for electrical equipment do not vary in the same ratio as the load upon the road, analysis of expenses may easily show that for a lightly travelled road the cost of electric operation will be in excess of that of steam.

Mr. W. S. Murray, M. Am. Inst. E. E., Electrical Engineer of the New York, New Haven & Hartford Ry., took exceptions to many statements in Mr. Wilgus' paper, particularly those which tended to show the superiority of the direct-current over the single-phase in the trunk line and terminal operation of the New York Central. The three main objections to the single-phase system as given by Mr. Wilgus were the insufficient practical development of the alternating-current system for a trunk line problem requiring absolute reliability of service, restricted clearances which forbade the use of overhead conductors, and legal obstacles to the use of overhead trolley within the limits of the City of New York. In answer to these objections Mr. Murray said that the single-phase system had operated in many railways with great success, that the N. Y., N. H. & H. R. R. is now operating on single-phase with just as many small clearances as its neighbor road, and lastly that the New York Central has not found the legal obstacles too great to keep them from placing much overhead work in their yards and terminals. In reply to this criticism Mr. Wilgus said that the reliability of the direct-current traction on the N. Y. C. R. R. during the past winter in contrast to the many breakdowns on the companion single-phase N. Y., N. H. & H. R. R. was proof enough of the superiority of the former. He also claimed that the Park Ave. tunnel alone was sufficient reason for the rejection of an overhead system, which required clearance. Lastly the overhead work in the yards is only temporary pending a legal decision and can be easily removed if found necessary.

The discussion was continued by Mr. W. B. Potter, M. Am. Inst. E. E., of the General Electric Co., Mr. George Gibbs, M. Am. Soc. C. E., of the Pennsylvania Tunnel and Terminal R. R. Co., Mr. F. J. Sprague, M. Am. Soc. C. E., Mr. H. M. Brinkerhoff, M. Am. Inst. E. E., and Mr. H. G. Stott, President of the American Institute of Electrical Engineers.